COMMONWEALTH BUREAU
OF
PASTURES AND FIELD CROPS
B. REF.
RECD. OCT 1957
Ab. by
DATE
Ab. articles: pp.

HERBAGE REVIEWS

HERBAGE PUBLICATION SERIES

VOL. 2. NOS. 3-4.
SEPT. - DEC. 1934.

PUBLISHED BY THE
IMPERIAL BUREAU OF PLANT GENETICS: HERBAGE PLANTS
ABERYSTWYTH, GREAT BRITAIN.

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SELECTED ARTICLES

STRAIN IN PERENNIAL RYEGRASS AND COCKSFOOT,

With particular reference to types found in old pastures in New South Wales.

A. W. S. MOODIE,
Assistant Agrostologist, Department of Agriculture, New South Wales.

INTRODUCTORY NOTE.

The areas climatically suited for "English" grasses and clovers in New South Wales are situated on the narrow coastal plain and on the high tablelands beyond. Although this represents a relatively small proportion of the whole State, yet it is an important area in so much as it is better suited for close settlement than are the more extensive but more arid western portions of the State. The coastal strip on which ryegrass and cocksfoot are important pasture plants is approximately 700 miles long north to south and averages about 50 miles broad. The region is predominantly given over to permanent pasture of one sort or another. Dairy cattle predominate on the coast and foothills, while sheep and fatting cattle are important on the Tablelands. This article by Mr. A. W. S. Moodie of the New South Wales Department of Agriculture will indicate the significance of making available to the farmer adequate supplies of guaranteed seed of ryegrass and cocksfoot and the means by which it is hoped that official seed certification will assist in this developmental programme.—WM. DAVIES.

Perennial ryegrass (*Lolium perenne*) and cocksfoot (*Dactylis glomerata*) are two of the most important grass species used for pasture improvement purposes in New South Wales, but as farmers have paid little attention to seed production, practically the whole of the seed sown is imported from New Zealand and Europe. Dependence on imported seed has to some extent retarded systematic investigation of local strains as the work was considered of little value unless supported by an established seed producing industry.

The significance of strain in pasture plants has been recognised by local grassland workers for many years, and hundreds of strains of perennial ryegrass and cocksfoot were tested with the object of advising seed importers to purchase outstanding tested strains. Preliminary "nationality" tests clearly indicated that it was impossible to rely on the strain value of seed from any country, and even strains from reputable overseas institutions were sometimes of little value for permanent pastures. In the pre-certification period it was impossible to purchase absolutely reliable lines of perennial ryegrass or cocksfoot on the local market, and the advisory worker was placed in the extremely difficult position of knowing that perennial ryegrass and cocksfoot recommendations were requested in many instances, and knowing equally well that the available commercial seed lines would produce only short-lived pastures, and the confidence of the farmer would be lost as a result. At this stage it appeared that perennial ryegrass would be of minor importance in New South Wales, as in most instances the grass disappeared after two or three years, and reliable seed supplies were unobtainable.

Grassland farming is in its infancy as far as the general farming community of this State is concerned. The existence of reliable sources of seed of perennial ryegrass and cocksfoot of high strain value has undoubtedly been an important factor in the considerable progress made in recent years. Before such lines of seed were available the farmer went to the expense of cultivating and preparing land, and pur-

chasing and sowing seed of costly mixtures of grasses and clovers, and the usual result was the disappearance of the ryegrass in a year or so, and the survival of cocksfoot plants of poor low-producing type. Under such conditions rapid progress was impossible as farmers naturally did not consider the work worth while.

The institution of seed certification in New Zealand and the results obtained locally from certified seed altered the outlook entirely as regards perennial ryegrass and cocksfoot, and this, combined with a growing interest and activity in local seed production, has been primarily responsible for investigations to ascertain the value of local regional strains of these grasses.

PERENNIAL RYEGRASS.

It has not been possible to ascertain the exact source of the introduction of perennial ryegrass into New South Wales, but it is almost certain that early seed supplies came from the United Kingdom. Early settlers in the Illawarra districts in 1830-1850 are said to have obtained ryegrass seed from the Government farm at Parramatta, and records show that it thrived on the fertile virgin soils. From the Illawarra districts seed was sent to the adjoining tablelands (Moss Vale, Bowral), where it proved equally successful under the different conditions of soil and climate. In these sections are found the most extensive and oldest areas of naturalized ryegrass in the State, some having grown undisturbed for over 80 years, and this in the absence of measures to maintain soil fertility.

Importance. With the introduction of certified lines of seed, perennial ryegrass can now be confidently recommended to farmers on the high fertility soils of the coast, tablelands and parts of the slopes divisions of the State. The low fertility soils of these divisions can be economically raised to ryegrass fertility by the subterranean clover-superphosphate combination, and this will greatly increase the area likely to be sown to ryegrass in future years. In the coast and tableland divisions the area of farm holdings is 32,085,958 acres, of which only 756,326 acres are under annual crops and 2,180,226 acres under sown pastures. Making due allowance for mountainous and other unsuitable country, it is obvious that there is ample scope for pasture improvement work, in which perennial ryegrass will ultimately play a prominent part.

Regions. Perennial ryegrass is naturalized in New South Wales on high fertility soils in districts where the rainfall varies from 18 inches to upwards of 70 inches per annum. In districts of low rainfall (18-22 inches) it is found only on river and stream frontages where the moisture supply is reasonably good during prolonged dry periods. These low rainfall areas are all located on the tablelands where the winter period is long, and the evaporation lower than in other sections of the State with a similar precipitation. In regions of higher rainfall, perennial ryegrass occurs extensively on high fertility soils, and is never found in any quantity on the poor soils.

Testing Regional Strains. Preliminary work was undertaken in 1930 and promising results were obtained, especially in regard to persistency. In 1932 more detailed studies were commenced with a survey of the soil and climatic conditions of the regions where ryegrass is naturalized and the collection of representative material. Strain tests are being conducted at Glen Innes (rainfall 31.3 inches), Bathurst (rainfall 23.62 inches), Richmond (rainfall 29 inches), and Berry (rainfall about 50 inches). Single plant and plot studies are in progress, with control areas of New Zealand " Mother " and " first harvest " seed.

It has been possible to reach the following conclusions with regard to the strains under test :—

(*a*) the majority of the lines of seed collected in coastal districts were equal in type standard to New Zealand certified. They differ however, in regard to maturity, being at least three to four weeks earlier in running to

seed. Although this results in a shorter summer grazing period, it is probably of little economic significance because in coastal districts, we utilize ryegrass primarily for the production of autumn, winter and early spring grazing; before the ryegrass reaches maturity it is usually supplemented by the early summer growth of *Paspalum dilatatum*.

(*b*) lines from centres of regular rainfall in tableland districts proved similar to the coastal types and were equal to New Zealand certified.

(*c*) lines from low or irregular rainfall areas in tableland districts were inferior to (*a*) and (*b*), and in most instances, would be classified as false perennials.

The climatic conditions of the perennial ryegrass regions of New South Wales and New Zealand probably differ in sufficient degree to have influenced the evolution of distinct ecotypes and it is also likely that different grazing methods have had some bearing on the matter. The regions of New South Wales in which ryegrass is naturalized are subject to periodic spells of dry weather normally of longer duration than any experienced in New Zealand. The summer season is longer with higher maximum temperatures, and the winter season shorter with higher minimum temperatures. It is also worthy of note that our best naturalized strains have evolved in districts where sheep have never been kept, while in New Zealand the pastures have been grazed for many years by both sheep and cattle.

It is obvious that in New South Wales we have areas of naturalized perennial ryegrass which can be utilized for the production of seed of good strain value and the Department of Agriculture has offered seed producers the protection of a seed certification scheme on lines similar to that operating in New Zealand. With the installation of efficient cleaning machinery, it is likely that considerable progress will be made during the next few years, and that ryegrass grown in New South Wales will become of commercial importance.

COCKSFOOT.

Cocksfoot is an important constituent in most pasture mixtures sown by local farmers and has been so used for many years past. There exist, however, many old paddocks which bear mute testimony to the poorness of imported strains, and in summarizing the results of a survey of local cocksfoot areas, one can only come to the conclusion that very little seed of good strain came to New South Wales from overseas. While the persistency of these strains was undoubtedly superior to the persistency of perennial ryegrass from similar sources, the strain value was extremely poor in all other respects and we have very few, if any, areas equal to certified "Akaroa."

Most of our material for strain testing has been collected from old paddocks in Northern Tableland districts, but local strains have so far proved inferior to the best Akaroa in regard to type, particularly leafiness, and superior to commercial Danish, in type and persistency.

At the moment it appears unlikely that any outstanding regional strains of cocksfoot will be developed commercially in New South Wales and seed areas will have to be established from certified "Akaroa" and from élite strains developed locally.

MIGRATION AND DISTRIBUTION OF RED CLOVER IN EUROPE.*

BY

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(Translator—G. M. Roseveare).

A glance at the area in which wild red clover is distributed (Fig. 1) shows that the species must be composed of an enormous number of regional types, that a great wealth of physiological tendencies, emanating from a central line, must comprise a total complex, enabling the species to maintain its equilibrium amidst the most widely varied environmental factors.

FIG. 1.—AREAS IN WHICH THE THREE RACIAL GROUPS OF RED CLOVER ARE DISTRIBUTED.

Diagonal lines=Atlantic groups (Early, Brabant, Norman and Spanish clovers.)
Horizontal broken lines=Central Alpine group (Late-flowering red clover or cowgrass=Mattenklee.)
Dotted areas=Continental groups (Late, green and Styrian clovers.)

[In localities with more severe climate the continental clover is apt to encroach upon Atlantic regions.]

*This article represents a much abridged translation of another article by the author, entitled "Die Konstitution des Rotklees"; published in *Die Ernährung der Pflanze*, Vol. 30. pp. 81-9. 1934. The full translation from which this article has been taken, together with the bibliography, is available on request.

Red clover is a " ubiquist," that is to say, it is a plant which may occur in practically any community, and is thus a plant with a low degree of fidelity to the community. Red clover is of " indifferent " or " strange " constitution in relation to the community (Braun-Blanquet). Sociologically it may be compared to *Ranunculus acer*. From the historical point of view red clover may be described as of archaeophytic, autochthonous constitution in Eurasia, that is to say, it belongs to the inventory of actually cultivated plants, whereas in North America it must be regarded as an anthropochorous plant, that is to say, one introduced by human agency. The slight degree of differentiation in its external structure has often caused it to be forgotten that the " ubiquist " red clover is able to maintain its position over large areas of land only by reason of an enormous wealth of internal differentiations. The " morphological study of race " has been very detrimental to the practical cultivation of red clover and has always resulted in its decline. There is every justification to-day for making this assertion. The characteristics of the regional types and their special physiological values have long been underrated. In spite of the geographical compactness of the red clover area, which seems to bridge over all zones from humid to arid climates, the humid component of the species complex *Trifolium pratense* is clearly dominant. The further south one goes, the more does red clover become a plant of hill climates (Fig. 2.). There are definitely

FIG. 2.—WILD RED CLOVER AREA.

" Atlantic " races within the species, races which are endemic in coastal regions, but it would be a great mistake to regard the physiological constitution of red clover as approximating to that of the Atlantic *Ornithopus sativus*. *Ornithopus* is much less a plant of light and sunshine than red clover. Red clover is known to be a

coastal plant to a secondary degree only, by adaptation and acclimatization. But *Ornithopus sativus* has developed primarily in foggy countries and, as regards continental expansion, it is far outdistanced by red clover. The coastal forms of red clover, on the other hand, are genuine ecotypes, and offer a contrast to lucerne stands grown under moist atmospheric conditions; the generative decline of the lucerne within a short time shows that it is not composed of genuine ecotypes. The primordial position of red clover in space lies between that of *Ornithopus sativus* and lucerne; it still belongs definitely to a humid climate.

A basis for the description and comprehension of the history and the migration of the cultivated clover and for the evaluation of the regional types, an understanding of which is a necessary condition of successful clover growing, may be found in the study of several characteristics of the clover plant in relation to its environment and cultural treatment.

Soil reaction, effect of gypsum and superphosphate, requirements as regards soil and atmospheric moisture, resistance to disease, etc., are all aspects that have to be considered.

The story of red clover is for a long time one of set-backs. It begins comparatively late and is slow in getting under way. The theory that red clover first assumed the rank of a cultivated plant in Spain (Fig. 3) is that which has the most

FIG. 3.—THE HISTORICAL BASES OF RED CLOVER CULTIVATION.

Large dots = localities in which temporary trials were made during the crop's early history.
Large dots with arrows attached = localities from which red clover cultivation spread.
Small dots = areas in which red clover cultivation ceased as a result of the Thirty Years' War.
Small circles = Kashira (1766) and Moscow (1790).

adherents. From thence red clover cultivation reached Holland about the middle of the sixteenth century, and at approximately the same time it gained an entrance into Lombardy (in the neighbourhood of Brescia, 1550). In Germany nests of red clover cultivation were formed, thanks to the Walloon colonists, in the Rhineland climate, in the central part of the Rhineland, the Palatinate and near Trier. The Thirty Years' War stamped out these beginnings and red clover cultivation once more disappeared. It was brought to England in 1650 by a German doctor named

Samuel Hartlieb who settled in England, although it had already been described by Sir Richard Weston in 1645 and by Walter Blithe in 1649. In Russia the growing of red clover is reported as early as 1766, but it was confined at first to the experiments of Bolodov in the Kashira district. It was not until 1790 that some farms in the Moscow district made actual trials of the crop. In 1819 in the Government of Jaroslav the introduction of the plant is said to have been enforced, indigenous wild clover being used after the failure of foreign varieties. The nucleus of the winter-hardy clover was thus formed. In 1883 the attention of other districts was attracted by this nucleus, and similar ones were formed in Tura and Orel. In 1912 Russia exported over 10,000 tons of clover seed.

The resistance of the countryfolk to the introduction of the red clover was everywhere great, and recalls the early history of potato and lucerne growing. In the case of the last two species, however, entirely foreign plants were concerned, whilst in the case of red clover it was merely the presentation of a familiar plant in a new guise. Possibly the very fact that it lacked the charm of novelty militated against it.

The man who most faithfully blazed the trail for red clover cultivation in Germany was Johann Christian Schubart, who was born in 1734 in poor circumstances and who later attained great breadth of outlook through travelling and a thirst for education. In 1769 he purchased with his wife's dowry the estate of Würchwitz, near Zeitz, and there began his clover experiments in 1775. In 1783 he won the prize of the Berlin Academy of Science for the best essay on " The various properties and the successful growing of forage plants." The Emperor Joseph II raised the pioneer of clover cultivation to the nobility in 1780. J. C. Schubart, Edler von Kleefeld, died in 1787. The development of clover cultivation up to the present day is shown in Fig. No. 5 of the Supplement to the article "Die Konstitution des Rotklees."

Wherever the clover was introduced, it became crossed with the wild types growing in the locality, and thus have arisen the numerous indigenous varieties. In the course of time there emerged spheres of action in which grew combinations of types of especial vigour, and we will endeavour to see where these areas gradually became defined and how "special varieties" developed.

There were two main centres, Brabant and Styria, where the growing of clover became most dense and from whence it became disseminated. As long ago as 1859 the agronomist Schwerz noted this division ; he spoke of Brabant and Spanish clover and of green and Styrian clover. He was followed by Koppe in 1861. The ecological connections were not yet recognized at that time. The area of cultivation is shared by two main races of clover, in the one an Atlantic, in the other a Continental component clearly dominant. In a central position, and best as regards ecological equilibrium, stands the alpine late-flowering red clover or cowgrass (*Trifolium pratense* subvar. *perenne* Sinclair), known as "Mattenklee" in Switzerland and " Schweizerklee " amongst the herdsmen in the Cantons of Bern and Zürich. In many respects this clover is still a primitive race, especially in being more closely attached to the ground, in its general aspect, which resembles the wild form more nearly than that of the other forms, and in its greater persistence. This primitive character does not seem to have been conducive to an extension of its cultivation. It has been, and still is, under-estimated, although in 1914, as a result of variety trials in the Fichtelgebirge, it was described by H. Raum as the clover race exhibiting the greatest productivity. In the Black Forest, in the Vogesen and the alpine foothills as far as the Danube, this late-flowering red clover is said to have made greater headway than formerly. Unfortunately it fruits slowly and with difficulty in alpine regions. The requisite conditions for its cultivation seem on the whole to be present in Central Europe. In the case of the other, much larger racial groups, the growing of red clover of continental origin in an Atlantic region seems to be more successful than the reverse process. The history of clover cultivation goes from west to east,

but the constant setbacks which accompany its early history come from the counteraction of the east (Fig. 2). Only when the "late" or the "eastern" clover spread westwards again from the east did the cultivation of clover become to some extent stabilized. In the fresh combinations of western and eastern types the new local types took a place. The history of this process may be clearly traced. No East Prussian landowner would to-day repeat the experiment of growing Brabant clover. The seed trade in red clover is still in its earliest stages ; only when ecological requirements are better understood will the cultivation of red clover come into its own and the breeding of red clover receive a fresh impulse. Until then the practice of growing Atlantic and continental races simultaneously, which is customary in many parts, may be regarded as a satisfactory arrangement. It is, however, only a kind of insurance.

Above all the subject of red clover must be outlined afresh in the simplest manner and all confusing classifications must be retraced to a more simple formula. An attempt to do this has been made in this article.

In the first place the area of the wild red clover has, as far as this is possible, been defined. The area in which red clover is cultivated (adjacent on the whole to the winter cereal area) does not coincide with the natural area, nor does this occur in the case of any cultivated plant. Boundary conditions indeed generally result in much greater productivity in the cultivated plant, at the expense of its vitality. One thing emerges, however, from the expansion of red clover cultivation ; humidity is the dominant requisite. The dry southern steppes of Russia are passed over, and in America the centre of gravity lies in the humid western region. The American red clover, young as it is, is already to a great extent alienated from the original European forms. Poor results have been obtained from transplanting it back to Europe, just as has been reported in the case of the potato when replanted in its native habitat.

REVIEWS

A GRASSLAND RESEARCH PROGRAMME IN BRAZIL.

(Reviewer: G. M. Roseveare).

A comprehensive and clearly outlined scheme for the study of grassland in the State of Minas-Gerais and the reformation of its management has been drawn up by the Department of Agrostology of the Regional Inspectorate of Animal Production. It is under the supervision of Senhor E. C. Santiago, Junior.*

The authors first indicate the need for grassland research by a brief description of the present position. Minas-Gerais is fifth in size and first in population of the Brazilian States. The value of its animal products greatly exceeds the total value of the principal crops (coffee, sugar, rice, etc.), for which reason the grassland of the country, comprising 40,149,200 hectares or two-thirds of its area, is of primary importance. In common with that of all tropical and sub-tropical countries, it is deficient in protein and mineral content; on the other hand, bulk production is considerable, and is in inverse proportion to mineral content. Three topographical divisions are noted: (a) rough grasslands on the mountain slopes, liable to erosion; (b) the grasslands on the barren uplands which characterize the centre and large areas of the Triangle and West, used in the rainy seasons and composed of poor, stony soil and correspondingly poor vegetation; and (c) the better type grasslands of the intermediate zones, with soil naturally fertilized by detritus from higher areas. Hay-making and ensilage, whereby the evils of fodder shortage during the dry season might be eliminated, are practically unknown to farmers in the State; an extensive system of grassland farming, both for grazing and milk production, is general; and nothing is done to prevent soil exhaustion. The last-named drawback is the more serious since the greater part of the grassland of the State has grown upon what was originally arable land, and the soil was therefore more or less impoverished before the herbage appeared. The principal components of the sward are *Melinis minutiflora*, with its three varieties purple, white, and "negro's hair"; *Hyparrhenia rufa*, *Panicum equinum*, and *Panicum maximum*. That there is an unusual abundance of other components, however, is revealed by botanical analyses made in the vicinity of Pedro Leopoldo, the seat of the Inspectorate, no less than 155 grass and 132 legume species being listed. Of the legumes growing wild in the region, more than ten are of creeping habit, and resemble the subterranean clovers cultivated in Australia; all are rich in nitrogen-fixing root nodules. According to the information at present available, there is a regular distribution of herbage plants in the State, allowing of its division into five agrostological zones, although subsequent exploration and research may modify this division.

*Joviano, R., and Santiago, E. C., Junior. Contribuição para o estudo de agrostologia no Estado de Minas-Gerais. [The study of agrostology in the State of Minas-Gerais.] Bol. Agric. Minas-Gerais. Vol. 7. No. 4. pp. 197-212. Belo-Horizonte, 1934. [Inspetoria Regional do Fomento da Produção Animal, Pedro Leopoldo, Minas-Gerais, Brazil.]

The following are the objects envisaged by the programme of the Department of Agrostology:

I. Experimental work.

1. SOIL IMPROVEMENT.

   (a) The reconditioning of exhausted grassland soils. Manurial trials for the determination of requirements for maximum production.

   (b) Manurial treatment with special reference to palatability and the mineral composition of herbage.

   (c) Cultural methods and their effect upon the soil, with reference to (i) the improvement and conservation of the grassland, (ii) the production of herbage.

   (d) The effect of burning upon grassland soil.

   (e) Soil correctives.

2. HERBAGE AND FORAGE PLANTS.

   (a) Exploration. All promising regions of the State to be explored in search of plants of possible agricultural value.

   (b) The adaptation of exotic plants and the domestication of indigenous plants, which would be tested for:
   Growth habit;
   Drought resistance;
   Productivity;
   Seasonal growth;
   Proportion of stem to leaf;
   Palatability;
   Reproductivity;
   Behaviour under grazing;
   Behaviour in pure sowings for cutting.

   (c) The above-named studies will be made in the first place of grasses, legumes, and tubers. Legumes will be classified according to growth habit (creeping, shrub-like, etc.), and according to their utility in improving or maintaining pastures and furnishing material for cutting leys.

3. GRASSLAND WEEDS.

   Investigations will consider the possibility of utilizing such weeds, as well as economic methods of control.

4. WINTER CEREALS FOR FODDER.

5. BOTANICAL RESEARCH.

   (a) The classification of indigenous forage plants and exotic forms of the same genera. Botanical study of the flower and fruit.

   (b) The institution of a herbarium and museum of wild and exotic forage plants, including legumes, tubers, and other plants of nutritive value.

   (c) The floristic composition of the State.

   (d) Botanical analyses per zone, per unit area, in accordance with soil variation and the normal vegetation.

   (e) Changes produced in the botanical composition of the sward by different forms of treatment, including burning, and the practical significance of such changes.

   (f) The recording of material and observations as a basis for future study and the creation of new forms.

6. CHEMICAL AND BIOCHEMICAL RESEARCH.

(a) Investigations to throw light upon the variability in the protein and mineral content of the Minas-Gerais herbage as affected by the seasons, different cultural methods and various forms of management.

(b) The determination of chemical transformations incurred by ensilage and haymaking under tropical and sub-tropical conditions, and correlations in regard to animal nutrition which may be deduced therefrom.

(c) The determination of the effects of burning upon soil humidity, the production of green weight, change in the colouring and earliness or lateness of the herbage.

(d) Ascertaining the economic value or otherwise of feeding concentrates to cows already kept in rich pastures.

(e) Determination of pasture yield with and without the application of fertilizers, with reference to quantity, quality, succulence, digestibility, and total of nutrients in the mass.

7. HAYMAKING AND ENSILAGE. This is a subject of outstanding importance in a region like Minas-Gerais, with a rainy summer and in winter periods of drought with corresponding shortage of green feed.

(a) Investigations on : the best time for mowing, the stage of development of the plant, the best ensilage and haymaking methods, the correct temperature, mixtures, and finally costs.

(b) A study of the above items in relation to nutritive value, the conservation and utilization of hay and silage.

8. CEREALS AS CONCENTRATES.

9. PASTURE MANAGEMENT. A study of the biotic factor, in relation to different grazing systems.

(a) The reaction to grazing of different species of herbage plants, in various soil types (such as characterize the grassland regions of the State), at various stages of growth, and under various climatic conditions.

(b) Evaluation of pasture units in the State, according to area, quality of herbage, specific production after grazing, and season of the year.

(c) The determination of the total herbage production of pastures in relation to the percentage used, with a view to providing a stimulus to improved grazing technique. If the percentage of losses incurred by the farmers of Minas-Gerais through irrational pasture management are known, even approximately, more interest and attention will be devoted to the subject and the establishment of rational grazing standards will be facilitated.

(d) Finally the study and control of the biotic factor is necessary as a basis of reforming the current extensive system of pasture management.

10. POISONOUS PLANTS.

(a) Catalogue and herbarium.

(b) Methods of eradication.

(c) Botanical study of species and varieties ; including classification, systematic, and according to geographical distribution and degree of toxicity.

(d) Chemical and biological study.

II. Extension work.

1. EDUCATIONAL.

   (a) Practical object lessons in grazing methods and pasture management. Discouragement of haphazard burning.

   (b) The encouragement of haymaking and ensilage for the prevention of fodder shortage during the dry season.

   (c) Reform of the customary methods of animal nutrition, and introduction of the normal use of balanced rations.

2. THE PROPAGATION AND DISTRIBUTION OF FORAGE PLANTS.

3. THE CONTROL AND ORGANIZATION OF THE SEED TRADE IN FORAGE PLANTS.

   (a) Certification of quality.

   (b) The creation of an organization for the compulsory testing of germinability and agricultural value in commercial seed.

   (c) The encouragement of technique in seed production and selection.

AGRICULTURAL EXPERIMENTS IN NORWAY.

[Reviewer—RHODA PETER JONES.]

The Council of Agricultural Experiments, which consists of all the directors of State Experiment Stations for Plant Cultivation, the director of the Experiment Station of the Peat Land Association and the director of the Experiment Station for Pasture Cultivation of the Society for Norwegian Welfare, held a conference early in 1934 to discuss various questions concerning the work of the experiment stations.

The most important matters dealt with were time of cutting trials and the plant breeding question.

The time of cutting trials were carried out at all the experiment stations for plant cultivation and at the Experiment Station for the Cultivation of Peat Land. The trials comprised from 5 to 6 harvest years, and the total number of time of cutting plots harvested was 78. The Agricultural College of Norway in collaboration with the experiment stations carried out analyses and feeding trials with hay from the time of cutting trials to determine the fodder value of the hay after the different times of cutting. When the results are published—probably during the autumn of 1934—the material available in this sphere will probably be the most comprehensive in Europe.

Only during the last 3 to 4 years have grants been allocated directly in Norway to plant breeding work. The varieties produced as the result of breeding work have been, and continue to be, of great economic importance, as they have been included in practical agriculture in overwhelming amount in proportion to the old land sorts which were predominant before breeding work was initiated. Foreign varieties also have been replaced by improved Norwegian strains.

The Council is of opinion that in Norway it is not advisable to separate plant breeding work from experimental work. [From Tidsskr. norske Landbr. 41. 154-9. 1934.]

PASTURE INVESTIGATIONS AT STORRS, CONNECTICUT, U.S.A.

The forty-fourth Annual Report of the Storrs Agricultural Experiment Station for the year ending June 30th, 1932, contains the third, fourth and fifth reports of the Station's work on pastures, by B. A. Brown. The third report (Bulletin 187, July, 1933) deals with the " Effect of fertilizers on the botanical and chemical composition of the vegetation in permanent pastures," the fourth with the " Effect of fertilizers on the total and seasonal production (Bulletin 189, August, 1933)." The fifth report (Bulletin 190, August, 1933) gives a resumé of thirteen years of research on pastures.

When the Station first made preparations for a pasture experiment in 1919, the need for investigating this subject had been apparent in Connecticut, as well as other northeastern states, for many years. The ordinary permanent pastures had become so unproductive that prominent dairymen placed very little value on them as a source of feed for their milking cows. The relatively large area of this type of pasture in Connecticut suggested that the study of its improvement was the most important problem. The first experiment was, therefore, laid out on a rather typical brush-grown, rocky, rundown permanent pasture. The results of this original and several later experiments have appeared in Station bulletins and are briefly summarized in one of the present Bulletins (No. 190).

The resumé is divided into three parts. Under the head of permanent pastures the effects of fertilizers on (a) total production, (b) seasonal production, (c) changes in kinds of plants and chemical composition of the pasturage are noted, while other aspects discussed are reseeding, management, bushes, type of land for permanent pastures, and acreage per animal.

Under the second head, " tilled, seeded pastures," the merits of the various grass and legume species for use on rundown land are discussed.

The third section deals with some farm practices suggested by the pasture experiments. A pasture schedule is tabulated for several crops, according to estimated days of grazing per acre for one 1,000 pound cow. The application of this schedule to two typical farms is explained ; the first farm has no alfalfa or sweet clover, the second farm has alfalfa.

PASTURAGE AND FODDER SUPPLY IN CEYLON.

A considerable amount of space has been devoted in recent issues of the *Tropical Agriculturist*, published by the Department of Agriculture, Peradeniya, Ceylon, to the problem of the provision of suitable pastures and fodders for sheep and cattle. It is considered that there are great opportunities for an increase in animal husbandry in that island. The rainfall is not of the type which would make the rearing of cattle an impossible proposition, and areas offering suitable combinations of proper temperature in relation to altitude can be found.

The great need is for greater facilities for grazing, both as regards areas available and type of herbage. It is considered that there is as good an opportunity for pasture improvement in Ceylon as in Australia and South Africa. While there is not an area of very uniform rainfall which is the ideal of a pastoral country, yet much of the island experiences the effect of two monsoonal rains with an intervening period not too long to give it the disadvantage of a drought. Only in an area in the extreme north-east and south-west are the effects of only one monsoon of importance, and here fodder crops could be cultivated.

The pasture problem in Ceylon would appear to be classifiable under three main heads :—

1. The provision of proper grazing grounds and their improvement.
2. The discovery and introduction into pastures of suitable indigenous or exotic grasses and legumes.
3. The introduction of fodder growing, with or without the immediate practice of ensilage.

Grazing Grounds and their Improvement.

A preliminary note on this question has been published by Senaratne (1). In 1932 there were 1,053,000 head of cattle, 527,000 buffaloes, 204,000 goats and 57,000 sheep in Ceylon, and according to a different source there were in 1933 15,000 acres of cultivated grass. There are no pastures, pasturage being provided by natural grazing grounds containing a very mixed flora in various stages of succession. These grazing grounds are (a) coconut grazing grounds, (b) semi-wild grazing grounds, and (c) Patana grazing grounds.

Coconut grazing grounds.

Practically all coconut lands provide grazing and carry cattle or other livestock for manurial, draught or other purposes. In these lands, which are chiefly in a strip along the sea coast, the grazing is of a more or less uniform and permanent character and consists of a mixture of grasses and leguminous plants. The grasses include many of the better pasture types, while the legumes include *Desmodium triflorum* (common), *D. heterophyllum* (less common) and *Alysicarpus vaginalis* (fairly frequent).

Semi-wild grazing grounds.

These include various neglected areas where stock graze uncontrolled on any herbage which may be available.

Pantana grazing grounds.

These form a very distinct and homogeneous class with well-defined characters. They consist of large savannah-like areas of grassland composed mostly of coarse grasses of which only tender young shoots are eaten by stock.

These three types of grazing grounds have received little attention in the past and they are in a more or less neglected state. Many excellent herbage species occur in these areas, but as a result of the present system of continuous open grazing of the entire pasturage by the whole herd, the extension of the better species is prevented while that of the less useful ones is little checked. There is no doubt that there could be a very great improvement as a result of scientific management.

A considerable improvement would naturally follow as a result of controlled rotational grazing, fencing (with live or other fences), etc. This applies only to the permanent grazing grounds that are not artificially altered or improved by the introduction of new plants.

It is suggested that the development of new pasture land should proceed along the following lines: (1) acquisition, (2) gradual clearing and enclosure, (3) improvements by removing weeds and sowing better seeds, (4) manuring, and (5) draining.

In turning coconut estates into grazing lands it is suggested that a good mixture of selected grasses (*Axonopus compressus* and *Cynodon dactylon*) and legumes (species of *Desmodium* and *Alysicarpus*) should be shown without a cover crop.

Pasture Trials at Peradeniya.

The programme of pasture work which is in progress at Peradeniya as part of this pasture scheme consists of:

(1) the study of the elements of pasture areas in different parts of the Island,

(2) the collection of indigenous plants of possible value,

(3) the study of their growth habits and suitability for pasture by cultivation in small plots,

(4) the selection and testing of strains,

(5) the multiplication of plants for grazing,

(6) the study of suitable exotics.

Some preliminary results of trials of grass species at Peradeniya have already been published (Senaratne **2**). A few exotics have been included, but the majority are indigenous species. The pastures were laid down on a six-acre block in June-July, 1933; as the report was published in April-May 1934, it will be understood that it is merely a progress report. In each plot laid down to grass *Desmodium triflorum* was planted six inches apart in rows alternating with those of grass, as it was desired to see if it is possible to establish a grass and a legume together. Other legumes will be tested later. With one exception, no manuring has yet been done.

As regards climatic conditions on the plots, the rainfall figures for the period of the trial were (in inches): 1933. June=9.4, July=9.9, August=8.4, September=8.9, October=10.9, November=10.7, December=2.2; 1934. January=5.6, February=4.2, March=9.0. The plots are situated at about 1,550 ft. above sea level. The climate is warm and moist with an average temperature of 76°F.

Fodder Growing and Ensilage.

In a review elsewhere (**4**) of animal husbandry in Ceylon it is stated that fodder growing must be encouraged, especially where stud bulls are to be introduced. Quick results cannot be expected and a demonstration station will have to be opened.

The introduction of the use of fodder would mean also the introduction of stall feeding, which would probably be one of the greatest agricultural advances in peasant agriculture in the Islands, for it would lead on to a system of mixed husbandry with the conservation of cattle dung. The preparation of silage and the feeding of concentrates would be the final stage, but it is doubted whether the time and conditions are yet suitable for the introduction of these last methods.

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PASTURE RESEARCH IN TANGANYIKA.

The Annual Report of the Department of Veterinary Science and Animal Husbandry in Tanganyika for 1933 contains an extensive report on the pasture research which is in progress in that Territory, by R. R. Staples. This report will be reviewed according to the sub-division into sections adopted by the author (pp. 76-103 of Report).

Pastoral Conditions in Various Districts.

The notes which are given on the grazing conditions of an important cattle district in the Territory, namely, the Mbulu district of the Northern Province and the neighbouring areas of Karato and the Ngorongoro Crater, are the continuation of a series, the first of which dealt with Usukuma in the Lake Province, and appeared in the 1931 annual report. The main object is to record all available information for future reference, in order to gauge as accurately as possible any important vegetation changes in the pasture which may take place ; with a rapidly increasing stock population it is more than probable that these will occur. The information should also be useful in any investigational work which may be undertaken in connection with pasture improvement.

The aspects which are discussed as regards Mbulu are general characteristics, stock, economic needs, climate, topography and soils, soil erosion, vegetation, composition of the grasslands, conservation and improvement of the pastures (development of rational grazing, cultivation of fodder plants). As regards Karato, East Coast fever, soil, water, tsetse, cattle and vegetation are reviewed.

The section on the Ngorongoro Crater is of particular interest. There are probably few places in Africa of such interest to the student of pastures. Situated in the midst of one of the youngest of the volcanic areas of Eastern Africa and on the edge of the Serengeti game reserve, it is the seasonal home of a truly spectacular number of game. The crater itself, although little more than 100 square miles in extent, is estimated to carry upwards of 80,000 head of game besides about 20,000 Masai cattle for six or seven months of the dry season and when the seasonal waters of the Serengeti reserve are dried up. All the various types of game are maintained in excellent condition until the very end of the dry season.

The " floor " of the crater is particularly interesting as it is here that the densest concentrations of game are found ; for some four to five months of the year the best pastures of this area must have an enormous carrying capacity. Not the whole is available for grazing, as besides permanently swampy areas and salt pan, there is a fair-sized forest of large *Acacia xanthophloea* on swampy ground. The remainder is grassland consisting of four main types, each an almost pure stand of one species. These four species are *Sporobolus spicatus*, *Cynodon plectostachyum*, *Pennisetum clandestinum* and a *Panicum* species, possibly *P. Hochstetterii*. All are described as being very palatable and having a very high carrying capacity.

As a pasture area the crater is of especial interest in East Africa in that the grazing seems to be the chief factor in maintaining the dominance of the grasses. On account of the closeness of the grazing, fire can rarely, if ever, play a part, except in the highlands.

The extraordinarily high carrying capacity is also most interesting, as it apparently has existed for hundreds of years and is possibly still slowly improving. This is partly due to the fertile soil conditions, but above all to the annual resting of the pastures combined with heavy manuring ; the enormous number of game droppings on the more productive pastures was one of their most striking features. The crater can therefore be regarded as a valuable natural demonstration of the benefits of resting and manuring of pastures.

PASTURE IMPROVEMENT.

After bearing certain local considerations in mind, the most promising work on which to concentrate (apart from improvement through range management) would appear to be the thorough trial at suitable centres, representative of the important stock areas, of promising indigenous and exotic pasture and fodder plants for the two-fold purpose of :

(a) the determination of pasture species which can be successfully used in rotation in the system of shifting cultivation in general use throughout the Territory ;

(b) the determination of species which will give the largest yields of palatable and nutritious fodder in districts where, through pressure of both population and stock, increased carrying capacity is most urgently required ; this information will be especially useful in any scheme to encourage mixed farming on small holdings.

GRAZING TESTS.

After testing the plant species as to their relative merits (methods are described) the most promising pasture species are finally subjected to a grazing test. An acre plot is used, without replication.

The method of estimating carrying capacity and the characteristics of the natural vegetation are described in this section. Some interesting information is available on the palatability of weeds and shrubs. The results of the trials as expressed in carrying capacity of a thicket plot and of cultivated pastures are given ; the species in the latter which are compared are *Cynodon plectostachyum* and *Cenchrus ciliaris*.

ECOLOGICAL NOTES ON PASTURES.

The main conclusions which have been reached in these studies are recorded in paragraphs on changing thicket to grassland, establishment of pasture grasses in cleared thicket land, tendency to revert to thicket, control of weeds, effect of trees on growth of grasses, and effect of protection on an overgrazed and eroded area.

RANGE MANAGEMENT : SEASONAL USE OF PASTURES.

After careful consideration the author is convinced that the most effective method of improving the fodder supply from pastures is the introduction of suitable systems of rotational grazing. Cultivation of pastures requires a great deal of work while grazing management is merely a matter of organization.

A system of rotational grazing for Usukuma is described. When all the difficulties connected with the use of this system are surmounted, there remains the most difficult step of introducing this scheme of grazing into tribal practice.

* * *

The remaining sections of the report deal with (a) demonstration stock farms, (b) effect of fire on mountain grassland, (c) a run-off and soil erosion experiment, (d) erosion control, and (e) water conservation in sub-arid Tanganyika.

The Report is obtainable from the Government Printer, Dar es Salaam, Tanganyika, price four shillings.

PASTURES AND FODDERS IN NORTHERN RHODESIA.

A large portion of the 1933 issue of the Annual Bulletin of the Department of Agriculture (obtainable from the Government Printer, Livingstone, N. Rhodesia, price two shillings and sixpence) is devoted to pasture investigation. The work described is more suggestive than conclusive, but since it must be suspended owing to drastic reductions in staff, it was considered desirable to make a permanent record of the initial progress in this subject.

The first article, " The aims of pasture management in Northern Rhodesia," by C. G. Trapnell, deals with such topics as the selection of land, the rôle of fire, problems of management (uneven grazing, lack of winter feed) and methods of grazing management (rotated summer pasture, mown rotated pasture, mowing for fodder, use of old lands, cultivated grass). The objects of this account have been to state the problems of pasture in Northern Rhodesia, and the principles of management which they indicate. Further experimental evidence and trials of the practicability of proposals are prohibited by financial restrictions. An account of inferences made to date was therefore considered justified.

The account refers primarily to the problems of management of the *Hyparrhenia-Brachiaria* grasslands of Thorn Country and allied types of the " Sweet Bush Grasslands," in which most Northern Rhodesian farms are situated. The rapid growth of the tall grass of this country causes eneven grazing and consequent veld deterioration. It is also accompanied by a very marked seasonal fall in the nutritive value of the grass, which results in a serious deficiency of feed during autumn and winter. A study of grassland succession and the analytical investigations of the Chemist suggest that regular grazing and consequent veld improvement, together with great prolongation of nutritive value, could be obtained by non-intensive rotational grazing in paddocks smaller than the large camps prevalent, and by extensive use of the mower.

After reviewing the suitability of adopting such a system under local conditions, Trapnell states that the proper management of natural grassland would render cultivated pasture unnecessary in the Thorn Country except under special circumstances or for improved winter grazing. As a grass which can be sown down is preferable, commercial and indigenous strains of Rhodes grass (*Chloris gayana*) are under trial.

As an appendix to this first article, Trapnell outlines the ecological succession in the Thorn Country.

The second article under review is on " The seasonal changes in the chemical composition of pasture grasses, 1932-33 " by H. B. Stent. The first section of this article deals with an investigation of the effect of monthly cutting on the chemical composition of herbage, while the second reports on the seasonal variation in the chemical composition of four species of grasses (*Digitaria setivalva, Chloris gayana, Urochloa pullulans, Brachiaria dictyoneura*) grown on the same soil. In the first section, it is shown that crude protein and phosphate content can be maintained at a higher level when the herbage is prevented from maturing. The yield of fodder is also increased by early cutting.

Trapnell supplies an appendix on the botanical composition of these plots in relation to seasonal changes.

Under the head of " Notes on some indigenous pasture grasses of Northern Rhodesia," Trapnell gives the qualifications of a good pasture grass for local conditions. It should be a free-seeding perennial, creeping by aerial runners or underground rhizomes, providing ample bulk of leaf with little stem, remaining green late

into winter and becoming green before the rains. It should be palatable at all seasons and maintain a high nutritive value into winter. Certain species which approach nearest to this ideal are described: *Brachiaria dictyoneura, B. nigropedata* and *Brachiaria* sp. nov., *Digitaria setivalva, D. gazensis, Urochloa pullulans* and *Chloris gayana.*

The final article under review, "The pods of native trees as food for stock," by C. G. Trapnell and R. G. Miller, concludes that the pods of *Acacia* and *Bauhinia* would appear to be very suitable for general feeding purposes, and that they provide, by reason of their abundance, their nutritive value and their digestibility, the obvious answer to the insistent demand for a fodder bush.

The Annual Report of the Department of Agriculture, Northern Rhodesia, for the year 1933 also contains reference to this pasture research.

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Compiled by M. HALL.

In this third bibliography of the grass genera series certain minor alterations have been made in compilation. Most papers of a popular nature have been eliminated and cross references are excluded. The majority of standard works and floras already included in previous lists are not repeated.

Acknowledgment is made of the valuable assistance rendered by members of the staff at Kew Herbarium.

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BUDAPEST, 1934.

The 16th International Congress of Agriculture was held at Budapest, Hungary, from 13-20 June, 1934. The 4th Section, devoted to Plant Production, included three principal reports as follows :

1. J. Camarachesco : The production of forage in a dry, continental, extreme climate.
2. E. Grabner and E. Schribaux : The importance of plant selection for the development of agricultural production.
3. A. Åkerman : The unification of the methods of qualification of wheat.

A series of special reports was delivered to the Congress by recognized European authorities on the first topic, the production of forage in continental climates.

Bulgaria : The production of forage in a dry continental climate, by K. Pavloff, Director of the State Experimental Station at Sofia.

France : The production of forage in a dry continental extreme climate, by E. Miége, Chief of the Agricultural Service, Director-General of Agriculture, Commerce and Colonization in the Protectorate of the French Republic in Morocco.

Hungary : The production of forage in a dry, continental, extreme climate, by J. Surányi, Budapest.

Italy : The production of forage plants in a dry, continental climate, by Professor L. Seggieri, of the Royal Institute of Agriculture of Portici, Naples.

Rumania : The lucerne cultivated in the steppe regions of Rumania, by A. Talashesco, Director of the Agricultural Service of Celatea, Albă.

Rumania : Comparative anatomical study of Sudan grass and Aleppo sorghum (*Andropogon halepense*) by Dr. C. Ilkievitch, Pasture Section of the Ministry of Agriculture.

Jugoslavia : The production of forage in a dry, continental, extreme climate, by Dr. B. Roganovič, Zagreb.

Jugoslavia : Sudan grass as a forage plant for dry regions, by Dr. K. von Šoštarič-Pisačić.

The experiences and views of the eight authors contributing special reports are collated and reviewed by J. Camarachesco in the first of the three principal reports noted above, under the following headings.

The natural conditions of climate.
Animal raising as a function of forage production.
Natural grasslands.
Cultivation of forage plants in arid lands.
Cereals as green forage and straw.
Method of cultivation of lucerne in a dry climate.
Lotus.
Certain varieties of sainfoin (*Onobrychis*).
Improved species of *Vicia*.
Sudan grass (*Andropogon sorghum* var. *Sudanensis*).
Johnson grass (Aleppo sorghum).
Topinambour (*Helianthus tuberosus*).
Ensilage of forage.
Vegetation in North Africa.
Some general conclusions.

The principal report covers sixty pages in all. According to a review in the Spanish journal *Agricultura, Madrid*, 6, 474-7. 1934, it was concluded that in the extension of agriculture due regard must be paid to the maintenance of an equilibrium between cereal growing and stock-requirements. In arid climates, the cultivation of forage plants should take precedence over the system of natural grasslands and of bare fallows, which should be gradually reduced. The study of the local flora is an urgent necessity as giving a solution to problems of drought and frost resistance, and also in assisting in the discovery of a " system " based on methods most suited to local conditions.

The surest means of establishing such a system will be found in the use of the most suitable species, more particularly of those possessing a well-developed root system, in the cultural methods which will promote preservation of soil moisture, and in the choice of rapidly developing plants which can be harvested before the summer droughts. Plants deserving special attention include Sudan grass ; the cultivation of the perennial Johnson grass should be absolutely prohibited, as it is of mediocre quality and very difficult to eradicate.

The Monthly Bulletin of Agricultural Science and Practice of Rome gives an English rendering of the Resolutions passed by the Congress [Vol. 25. pp. T324-36. 1934.] Other questions discussed at the Congress will be summarized in later issues of the same Bulletin.

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ABERDEEN, 1934.

The British Association for the Advancement of Science met in Aberdeen, Scotland, on September 5th-12th, 1934. The following papers were read in Section M—Agriculture, which was under the presidency of Professor J. A. S. Watson. An asterisk attached to a title indicates that an abstract can be supplied from the Journal of the Meeting.

Thursday, September 6th.—Discussion on cattle rearing and feeding.

J. S. Grant—Calf rearing or bringing out of pedigree stock.

M. Mackie—The fattening of store cattle.

Dr. E. S. Archibald—Canadian experiments on cattle rearing and feeding.*

Professor R. Rae—Systems of rearing and feeding for the production of young beef.*

H. J. Page and Dr. S. J. Watson—Fodder conservation and its place on the farm.*

Friday, September 7th.—Joint Symposium with Physiology Section on " Nutrition in relation to disease."

Monday, September 10th.—Professor J. A. S. Watson—Presidential address— .

Scientific progress and economic planning in relation to agriculture and rural life.

Sir A. D. Hall—Planning of agricultural production.*

A. McCallum—The diffusion of scientific knowledge to the farmer in Scotland.*

Professor W. G. S. Adams—Better living : the community movement in the countryside.

Tuesday, September 11th.—Joint discussion with Chemistry Section on "The chemistry of milk."

Joint discussion with Botany Section and Forestry Department on "Soil and ecological studies in relation to forestry and grazing."

Dr. W. G. Ogg—Introduction.

Professor J. Tiurin—Methods and results of Russian work (not read).*

Dr. A. S. Watt—Forest soils.

Dr. A. Muir—Forest soils.

Dr. G. K. Fraser—Peats and peaty soils.*

E. Wyllie Fenton—Some aspects of the influence of grazing on vegetation.*

Excursions were made to the Macaulay Institute for Soil Research, Craigiebuckler (Dr. W. G. Ogg), Craibstone Experimental Farm, North of Scotland College of Agriculture (Mr. W. Findlay), Rowett Research Institute, Bucksburn (Dr. J. B. Orr), and farms in the vicinity.

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AMSTERDAM 1935.

The Sixth International Botanical Congress will take place at Amsterdam Holland, from September 2,—7, 1935. The Secretary is Dr. M. J. Sirks, Wageningen, Holland. The Organizing Committee announces that the following topics have been chosen preliminarily for discussion in the sections :—

AGR., Agronomy.—(1) Interactions between roots and soil; interactions between plants. (2) Virus diseases. (3a) Weed flora as an indicator of soil conditions in agriculture. (3b) Grassland associations. (4a) Genetics and breeding of immune varieties. (4b) Inbreeding. (5) Importance of microbiological investigations in the study of agricultural problems. (6) Effect on the cycle of development in plants.

CYT., Cytology.—(1) Structure of chromosomes. (2a) Crossing-over versus conversion. (2b) Terminology of cytology and genetics. (3a) Pairing of chromosomes in polyploids. (3b) Reduction division in Fungi. (4) Chain- and ring formation of chromosomes. (5a) Submicroscopical structure of the cell-wall. (5b) Vacuome, chondriome, plastids. (6) Colloid chemistry of protoplasm; vital staining.

GEN., Genetics.—(1a) Experimental mutations. (1b) Genetical basis of size and form. (2a) Crossing-over versus conversion. (2b) Terminology of cytology and genetics. (3a) Sexuality in Fungi. (3b) Reduction division in Fungi. (4a) Genetics and breeding of immune varieties. (4b) Inbreeding. (5) Taxonomy and genetics. (6a) Plasm and genotype in their mutual relations. (6b) Lethal factors.

GEO., Geobotany, ecology, and phytogeography.—(1) Climax associations in N.W. Europe and N. America. (2) Cartography: (a) Vegetation maps; (b) Area maps. (3) Flora and vegetation area. (4) Plant geography in younger formations. (5) The halophyte problem. (6a) Classification and nomenclature of vegetation units. (6b) Miscellaneous papers.

MOR., Morphology and anatomy.—(1a) Size and form. (1b) Genetical basis of size and form. (2a) Phyto-hormones; general paper. (2b) Leaf-arrangements. (3) Flower morphology. (4) Female fructification and phylogeny of Conifers. (5a) Wood anatomy. (5b) Relations between anatomy and external morphology. (6) Morphology of Bryophytes.

MYC., Mycology and bacteriology.—(1) Differential characters in Hymenomycetes. (2) Nomenclature of Fungi. (3a) Sexuality in Fungi. (3b) Reduction division in Fungi. (4) Biologic forms of Fungi. (5) Importance of microbiological investigations in the study of agricultural problems. (6) Phylogeny and taxonomy of Phycomycetes.

PATH, Phytopathology.—(1) Biological basis of plant quarantine. (2) Virus diseases. (3) Various papers. (4) Biologic forms of Fungi. (5) Immunization. (6) Physiologic diseases.

PB., Palaeobotany.—(1) Geobotanical provinces in the older formations. (2) Caytoniales and Pteridospermae and the evolution of Angiosperms. (3) Flower morphology. (4) Plant geography in younger formations. (5) Synchronism and uniformity in palaeozoic and mesozoic floras. (6) Various papers.

PH., Plant physiology.—(1) Photosynthesis. (2a) Phytohormones ; general paper. (2b) Phyto-hormones ; various papers. (3) Oxidation, reduction and metabolism. (4) Permeability and the accumulation of mineral elements. (5a) Submicroscopical structure of the cell-wall. (5b) Translocation of plastic materials. (6) Influencing the cycle of development in plants.

SYS., Taxonomy and nomenclature.—(1) Various papers. (2) Caytoniales and Pteridospermae and the evolution of Angiosperms. (3) Flower morphology. (4) Female fructification and phylogeny of Conifers. (5) Taxonomy and genetics. (6) Phylogeny and taxonomy of Phycomycetes.

* * * *

ABERYSTWYTH, 1937.

The 4th Grassland Conference of the North and Central European countries will be held at Aberystwyth in 1937 under the presidency of Professor R. G. Stapledon.

Reference has been made to the papers read at the second Conference in Sweden and Denmark in 1930 [*Herb. Rev.* 1. 100-3. 1933]. The third of the series was held in Zürich, Switzerland, in 1934 ; the papers read at this conference will be reviewed in due course.

CURRENT RESEARCH

TABULATED EXTRACTS FROM REPORTS.

This section of *Reviews* is intended to be used as an introduction to the many scattered references to all aspects of research on herbage and forage plants which occur in Reports of Government and other Departments and Institutes. Readers interested in the research of a particular country will find extracts from such reports as have been received at the Bureau in the past six months under the name of that country ; the order of countries as arranged under the Decimal classification is given on p. 119. The number placed at the head of each section on the same line as the name of the country is the Decimal number, and is not to be confused with the numbers of the Research items. The former run from Scotland (412.5) to Australia (94) ; the latter run from item 1-68.

The most important part of this section is the Subject index, where all the research items and their lettered subdivisions are placed according to subject of the research. It will be noted that the subjects fall in the same order as that adopted in *Herbage Abstracts*, again the order of the Decimal classification.

Thus any investigator studying fodder conservation, for example, has merely to look up the 25 references which are given to research on that subject, and he will be introduced to experiments in progress, or just completed, in a wide variety of geographical conditions. In this particular example, references to research on fodder conservation will be found under the geographical heads, Scotland, Northern Ireland, England, Switzerland, India, South Africa, Tanganyika and the United States.

Certain New Zealand Reports have come under notice twice in the same year. For this reason only a few research items will be found under that country in this issue. Further details will be found on pp. 52-5 of this volume of *Reviews* (March-June number).

SUBJECT INDEX.

Subject of Research.	Research Items. Numbers and Letters refer to Sub-Divisions of Geographical Sections, commencing on Page 119 (Nos. 1-3).
Protein.	1(a), 55(g), 56(b), 57.
Nodule bacteria.	32(b), 55(b), 55(c), 55(d).
Biochemistry (*Vitamins*).	12(d), 12(e), 12(f), 12(g).
Physiology (*Metabolism*).	34(j).
(*Germination and growth*).	4(a), 4(b), 21.
Chemical composition.	20(a), 46(c), 51, 55(g), 55(h), 55(i), 59(e), 63(s), 65(c), 66(c).
Ecology.	2(f), 47(d).
Floras and systematics. (*Botanical analyses*).	5(f), 8(b), 8(c), 8(d), 8(e), 8(g), 8(j), 9(b), 16(g), 41(a), 41(b), 45(c), 45(e), 55(h), 59(a), 68(e).

Soils. 55(e), 55(f), 55(g), 63(i), 63(n), 64(a), 64(b), 64(f).

Soil (seed) inoculation. 55(a), 59(b), 64(d), 64(e).

Selection (*Seeds mixtures*). 5(a), 5(b), 8(a), 8(b), 8(c), 8(d), 14(f), 15(a), 16(a), 16(e), 17(a), 22(d), 24(e), 29(b), 42(h), 49, 55(k), 55(m), 63(c), 68(c).

Plant selection (*Resistant varieties*). 2(e), 2(d), 2(e), 16(d), 18(c), 24(a), 29(a), 34(e), 34(f), 36, 37, 42(e), 42(i), 43, 48(e), 50(c), 63(e), 63(l), 63(m), 63(n), 63(o), 63(t), 66(e).

Seed testing. 3(c), 3(d), 4(a), 18(a), 18(b), 21.

Plant breeding. 2(a), 2(d), 8(m), 22(e), 33, 42(g), 48(a), 48(c), 48(d), 48(e), 48(f), 57, 58(b), 63(h), 63(k), 66(a), 67(a), 67(b), 67(c).

Seed production (*Sowing*). 2(c), 8(a), 16(a), 16(b), 34(c), 38, 42(c), 48(b), 48(f), 59(c), 59(d), 63(c), 63(d), 63(j), 63(p), 66(b), 67(e).

Seed cleaning. 7(b).

Harvesting (*Cutting*). 8(g), 16(c), 30, 34(b), 46(c), 49, 53(b), 63(f), 63(r), 68(a).

Yields. 8(g), 8(h), 9(b), 9(c) 11, 13, 16(c), 27(c), 30, 32(d), 34(b), 35, 40(c), 42(b), 50(d), 55(h), 55(k).

Fodder conservation. 1(b), 1(c), 3(e), 4(c), 11, 12(b), 12(c), 12(d), 12(e), 12(g), 14(g), 17(b), 20(b), 24(b), 25(c), 27(d), 33, 41(c), 44(b), 46(a), 58(a), 60(a), 61(a), 62(a), 63(g).

Management. 3(b), 8(f), 8(h), 8(i), 8(k), 8(m), 14(c), 14(e), 15(c), 33, 34(a), 34(h), 39(b), 40(a), 40(b), 45(b), 47(b), 47(e), 47(f), 49, 55(n), 56(c), 58(e), 63(u), 63(v), 63(w).

Reclamation (*Draining, etc.*). 10, 47/(i).

Geophysical influences (*Erosion*). 47(g), 47(h).

Fertilizers. 3(a), 5(d), 5(e), 5(f), 6(a), 6(b), 8(b), 8(c), 8(d), 8(e), 8(g), 8(j), 8(l), 9(a), 9(b), 9(c), 9(d), 13, 14(a), 14(b), 14(d), 15(c), 17(c), 22(a), 22(b), 24(f), 30, 33, 34(g), 34(i), 40(c), 40(e), 42(d), 49, 50(a), 50(b), 50(d), 52, 53(a), 53(c), 53(e), 55(b), 55(j), 56(a), 59(a), 63(a), 64(a), 64(b), 64(c), 64(e), 68(a).

Diseases, weeds and pests. 7(b), 16(h), 19(a), 23, 28(b), 32(c), 53(b), 62(b), 66(d), 68(d).

Herbicides. 7(a).

Forage crops. 12(f), 22(c), 29(a), 31(b), 39(a), 41(b), 45(d), 48(a), 53(c), 53(d), 55(k), 58(c), 61(b), 63(b), 63(c), 63(s), 67(d), 67(e).

Root crops. 6(a), 6(b).

Grasses (*general*). 21, 31(b), 42(e), 42(i), 51, 55(l), 63(b).

Grassland, meadows and pastures. 3(a), 3(b), 5(d), 5(f), 8(f), 8(h), 8(k), 10, 13, 14(a), 14(b), 14(c), 14(d), 14(e), 15(c), 17(c), 27(c), 41(a), 42(b), 45(a), 45(c), 45(d), 45(e), 47(a), 47(b), 47(d), 47(e), 47(f), 49, 50(a), 53(d), 53(e), 55(h), 56(c), 61(d), 63(w), 64(b), 68(a).

Grass genera.

Cereals. 35, 60(b), 61(c), 67(a).

Avena. 17(b).

Maize. 22(e), 24(a), 24(b), 25(c), 33.

Poa. 16(a), 18(b), 21, 49, 55(f), 64(b).

Dactylis. 2(a), 3(c), 17(a), 21, 48(c), 49.

Agrostis. 16(a), 16(d), 16(f), 16(g), 49, 55(f).

Phleum. 2(a), 2(d), 2(e), 18(a), 48(d), 55(g), 56(a).

Cynodon. 46(c).

Lolium. 2(a), 3(c), 3(d), 17(a), 18(b), 21, 29(b).

Festuca. 16(b), 16(d), 16(f), 16(g), 21.

Arrhenatherum. 21.

Phalaris. 29(b), 63(h), 63(i), 63(q).

Tripsacum. 65(a).

Andropogoneae. 24(a), 24(d), 27(a), 32(a), 36, 42(g), 58(c), 60(c), 61(d), 67(c).

Pennisetum. 24(c), 25(b), 65(a).

Panicum. 24(d), 30, 31(a), 46(a), 65(a).

Melinis. 65(a).

Digitaria. 42(b).

Chloris. 29(b), 42(b), 42(f).

Spartina. 65(b).

Eragrostis. 32(a).

Legumes (*general*). 17(b), 21, 24(g), 28(a), 32(b), 43, 55(a), 55(c), 58(a), 63(a), 63(b), 63(d), 63(j), 64(c).

Legume genera.

Medicago. 21, 26(b), 27(a), 34(a), 34(b), 34(c), 34(d), 34(e), 34(f), 34(g), 34(h), 34(i), 34(j), 44(a), 44(b). 48(e), 50(b), 50(c), 52, 56(b), 59(c), 63(f), 63(m), 63(n), 63(p), 63(u), 67(b).

Trifolium. 15(b), 17(a), 21, 25(a), 26(a), 26(b), 29(b), 50(c), 55(e), 55(k), 55(l), 56(b), 63(l), 63(r), 63(t), 66(e).

Vigna. 24(g), 37, 58(c).

Glycine. 27(b), 38, 48(f), 50(c), 57, 58(b), 58(c), 59(d), 61(d), 63(k), 63(o).

Vicia. 50(c).

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Melilotus. 32(d), 50(c), 54, 63(e), 63(v).

Lotus. 21.

Cyamopsis. 32(d).

Dolichos. 32(c), 32(d).

Miscellaneous fodders. 39(b), 39(c), 44(a), 44(b), 46(b), 58(d), 66(a), 66(c).

Lawns. 16(a), 16(c), 16(e), 59(f), 66(d).

Grazing. 2(b), 5(c), 8(a), 8(b), 8(c), 8(e), 8(g), 8(j), 8(l), 9(a), 34(d), 35, 40(a), 40(d), 42(a), 44(a), 47(c), 53(a), 55(n), 64(b), 68(b).

Palatability. 42(d), 47(c).

Nutritive value. 1(c), 12(a), 12(b), 12(c), 12(h), 20(b), 27(c), 40(f), 44(b), 46(b), 56(a), 56(b), 60(b), 61(a), 66(c).

RESEARCH TABULATED IN GEOGRAPHICAL ORDER.

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Scotland, Northern Ireland, Irish Free State, England, 119—122

Sweden, Holland, Switzerland, India, Cyprus, 123—125

Straits Settlements and Federated Malay States, Sudan, 125—126

South Africa, Northern Rhodesia, Tanganyika Territory, 126—129

Canada, United States of America, British Guiana, 129—133

New Zealand, Australia. 133

SCOTLAND. (412.5)

Publication: **Annual Report of the Hannah Dairy Research Institute for the year ending 31st March, 1934.**

RESEARCH: **1.** (a) The biological value of the proteins of growing grass.
(b) Extension of experiments to include both artificially dried grass and grass conserved by other methods (possibly).
(c) Relative feeding values of different forms of grass silage.

LOCATION: Hannah Institute, Kirkhill, Ayrshire.

RESULTS: (a) Preliminary results indicate that grass proteins have a relatively high value for milk production.

Publication: **Report by the Director of Research of the Scottish Society for Research in Plant-breeding to the Annual General Meeting, 26th July, 1934, Edinburgh.**

RESEARCH: **2.** (a) Breeding of *Phleum pratense, Dactylis glomerata* and *Lolium perenne.*
(b) Observational grazing trials on areas of approximately 1 acre.
(c) Collection of data relating to seed growing methods.
(d) Maintenance of cross-fertilizing strains at a desired level of purity.
(e) Detection of changes in the composition of strains.
(f) The ecotype concept in relation to the registration of crop plants.

INVESTIGATOR: Dr. J. W. Gregor.

LOCATION: Scottish Society for Research in Plant Breeding, Corstorphine, Edinburgh.

COLLABORATION: With the Scottish Agricultural Colleges in the execution of item (b).

RESULTS: (a) Multiplications were made with two strains of pasture (diploid) timothy, one of a soft-leaved cocksfoot and one of perennial ryegrass (pasture strain).

(b) Observations should indicate suitable agricultural conditions for strains being studied.

(c)—(e) Study of environmental races of *Phleum pratense* and *Plantago maritima* is supplying information on the influence of environment on the heredity of plants composing a freely crossing population.

(d) See article in *Ann. appl. Biol.* 20. 205-19. 1933.

NORTHERN IRELAND. (416)

Publication: **Seventh Annual Report of the Agricultural Research Institute of Northern Ireland, Hillsborough, Co. Down. 1933-34.**

RESEARCH: **3.** (a) Renovation and manuring of grassland.
(b) Grassland improvement.
(c) Comparisons of commercial and indigenous strains of *Lolium perenne* and

Dactylis glomerata.

(d) Strain trials with *Lolium perenne*.

(e) Methods of making grass silage.

INVESTIGATORS: The joint directors and staff of station, the Seed Testing and Plant Disease Division, Ministry of Agriculture (S. P. Mercer and others) and Chemical Research Division, Ministry of Agriculture (R. G. Baskett and others).

LOCATION: Hillsborough Institute.

RESULTS: Details are given in the Report.

IRISH FREE STATE. **(417)**

Publication: Second Annual Report of the Minister of Agriculture, 1932-33. Dublin.

RESEARCH: **4.** (a) Seed testing investigations on the possibility of shortening the periods of germination.

(b) Inquiry into the value of broken seedlings with adventitious roots.

(c) Ensilage experiments.

INVESTIGATORS: Seed Testing and Economic Botany Division (a and b).

LOCATION: Seed Testing Station (a and b).
Department's farms and Albert Agricultural College (c).

RESULTS: (c) Sketch plans of suitable silos prepared and circulated. Rough grass not suitable, but aftermath, well packed and covered, made good silage.

ENGLAND. **(42)**

Publication: Agricultural investigations at the South-eastern Agricultural College, Wye, Kent, 1927-32.

SOURCE: Article in Journal of the College, No. 34. pp. 246-51. 1934. By H. B. Bescoby, Department of Agriculture.

RESEARCH: **5.** (a) Temporary seeds mixtures.

(b) Permanent grass seeds mixture.

(c) Intensive grazing.

(d) Permanent pasture fertilizing.

(e) Nitrogenous fertilizers for early grass.

(f) Investigations relating to botanical composition and the effect of fertilizing on yield of Romney Marsh grassland.

LOCATION: College Farms and other points.

COLLABORATION: Other Departments of the College.
Pasture Investigation Committee (f).

RESULTS: See report for details.

Publication: Jealott's Hill Agricultural Experiment Station, Guide to Experiments, 1934. Imperial Chemical Industries, Ltd., Warfield, Bracknell, Berks.

RESEARCH: **6.** (a) Effect of Nitro-Chalk on the yield in tons per acre fresh weight of kale.

(b) Effect of increasing rates of application of nitrogen on yield and feeding value of marrow stem kale, and the additional effects due to the application of extra phosphates and potash at the highest levels of manuring.

RESULTS: (a) Figures available for 1929-33.

RESEARCH: **7.** (a) Control of weeds in arable land by spraying with diluted mineral acids.

(b) Control of seed-borne disease by seed dressings.

RESEARCH: **8.** (a) Effect on seeds mixtures and pure seedings of rotational grazing when the fields are rested at certain periods of the year.

(b) Effect on botanical composition of a sward, sown with a simple grazing mixture, of various methods of grazing combined with manuring.

(c) Effect on the botanical composition of a sward, sown with a dual purpose grazing and mowing mixture, of various methods of grazing combined with manuring.

(d) Effect, on the botanical composition of a simple grazing mixture, of varying the time of application of a second dressing of nitrogen, a first dressing of nitrogen having been applied at the beginning of March.

(e) Effect on the botanical composition of an old permanent pasture of various methods of grazing combined with manuring.

(f) Study of a seasonal rotation of grassland management on an old permanent pasture.

(g) Comparative effect on botanical composition and productivity, of sheep grazing and mechanical cutting to various degrees of closeness, with and without manuring.

(h) Study of methods of management of a recently established pasture to produce (a) maximum early bite, (b) maximum autumn bite, and (c) maximum winter bite.

(i) Seasonal rotation of grassland management on a recently established pasture.

(j) Influence of autumn grazing together with manuring on the botanical composition of a young sward.

(k) Improvement of "tumbledown" pasture.

(l) Influence of degree of intensity of grazing coupled with varying applications of animal droppings.

(m) Behaviour of pure species and strains of herbage plants under various treatments.

RESEARCH: **9.** (a) Effect of nitrogenous fertilizers on intensively grazed pasture.

(b) Effect on yield and composition of herbage of rate and time of application of nitrogenous fertilizers.

(c) Effect of rate of application of nitrogenous fertilizers on the production of the "early bite."

(d) Comparative effect of different forms of nitrogen on the soil of a permanent pasture.

RESEARCH: **10.** Efficiency of tile and mole draining on grassland with superimposed manurial treatment.

RESEARCH: **11.** Study of the yield of nutrients from grass conserved at various stages of growth by hay-making, artificial drying and silage processes.

RESEARCH: **12.** (a) Feeding value of intensively treated autumn grass.

(b) Feeding value of products of conservation processes.

(c) Dried grass in the ration of the dairy cow.

(d) Influence on the natural colour of butter of artificially dried grass and A.I.V. fodder when fed in the ration of the dairy cow.

(e) Comparative feeding value of A.I.V. fodder and ordinary silage from the point of view of butter colour.

(f) Carotin content of pasture herbage.

(g) Vitamin content of grass silage and artificially dried grass.

(h) Digestibility of grass.

RESULTS: Some progress results of several of the items listed (**7-12**) are quoted in the Guide.

Publication: The Harper Adams Adviser. A Review of Advisory Work in the West Midland Province, 1933-34. May, 1934.

RESEARCH: **13.** The manuring of hay-land on two important local soil series, the "Powis" series and the "Peat."

INVESTIGATORS: Department of Chemistry.

RESULTS: The experiments have been in progress for three years and are now concluded. Yields and other data are given briefly in the report.

Publication: Record of farming practice and Guide to experiments on the Midland Agricultural College Farm, 1934.

RESEARCH: **14.** (a) Liming of old pasture.
(b) Nitrogen on grassland.
(c) Improvement of matted pasture.
(d) Effect of lime on matted pasture.
(e) Effect of surface cultivation on matted pasture.
(f) Trials with seeds mixtures.
(g) Use of silage.

LOCATION: Sutton Bonington, Loughborough.

Publication: Guide to the Experiments and Demonstrations in the County of Cambridge in 1934.

RESEARCH: **15.** (a) Seeds mixtures.
(b) Wild white clover trial.
(c) Improvement of permanent pasture by manuring and liming.

LOCATION: Farms in the County.

COLLABORATION: Ministry of Agriculture (b).

Publication: Report of the Board of Greenkeeping Research for 1933.

RESEARCH: **16.** (a) Testing of seeds mixtures and pure sowings of *Poa annua* and *Agrostis* for turf purposes.
(b) Seed production of *Festuca rubra*.
(c) Effect of cutting upon yield and persistency of turf grasses.
(d) Selection in the genera *Agrostis* and *Festuca*.
(e) Comparison of seeds mixtures versus pure sowings for fine sports turf.
(f) Collection of plants of *Agrostis* and *Festuca* representative of all known British species.
(g) Classification in the genera *Agrostis* and *Festuca*.
(h) Control of fungous diseases.

LOCATION: St. Ives Research Station, Bingley, Yorkshire, and various golf courses.

COLLABORATION: Golf clubs in England and Scotland.

RESULTS: (c) Intensity of mowing causes rapid deterioration; severe mowing in early spring has an adverse effect upon the persistency of turf grasses, particularly the fescues.

Publication: Report of the Board of Agriculture of the Isle of Man for the year ended 31st March, 1934. Report of the Agricultural Organiser.

RESEARCH: **17.** (a) Tests with *Trifolium pratense*, *Dactylis glomerata* and *Lolium* spp. in seeds mixtures.
(b) Mixtures of oats and legumes for silage.
(c) Manuring of grassland.

LOCATION: Knockaloe Experimental Farm, Peel, Isle of Man.

RESULTS: Yields and other data are given in the report.

SWEDEN. (485)

Publication: **Report of the Work of the Swedish State Seed Testing Station during the Fiscal Year 1932-33.**

SOURCE: Article by H. Witte in *Medd. Stat. Cent. Frokontr.* No. 9. pp. 3-57. Stockholm, 1934.

RESEARCH: **18.** (a) Seed testing of seed samples of plants, including 33 per cent of meadow plants.

(b) Testing of grasses (*Lolium*, *Poa*, etc.) for purity of species.

(c) Field inspection of meadow plants.

RESULTS: (a) Data are given for percentage of hulled seeds in *Phleum pratense*.

(c) 251 samples of meadow plants were tested.

HOLLAND. (492)

Publication: **Report on the work of the Phytopathological Service for 1933. Wageningen, 1933.**

RESEARCH: **19.** (a) Observations on fungous diseases on clovers, lucerne, lupins and grass.

RESULTS: Notes are made on *Sclerotinia* on clover, *Tylenchus* on lucerne, *Thielariopsis basicola* on lupins, and *Ophiobolus*, *Rhizoctonia*, *Asterocystis*, *Alternaria* and *Fusarium* on grass species. [A translation of sections of the report is available on request.]

SWITZERLAND. (494)

Publication: **Report on the work of the Oerlikon Agricultural Station for the year 1931.**

SOURCE: Article by Director (F. T. Wahlen) in *Landw. Jahrb. Schweiz.* 47. 797-872. 1933.

RESEARCH: **20.** (a) Chemical analyses of grass and hay samples.

(b) Analyses of hay and aftermath samples for nutritive value.

INVESTIGATOR: Dr. Fritz Werner and Section of Agricultural Chemistry.

RESULTS: (a) Phosphorus and potassium deficiency increases with altitude. Samples showing K_2O content of 2.5 per cent and over came from farms where liquid manure is widely used.

(b) Data are tabulated according to altitude, the highest group being 1300 m. and over.

RESEARCH: **21.** Seed testing of grass and legume seed.

INVESTIGATOR: Dr. A. Grisch and associates.

RESULTS: Data regarding purity and germinability, weed seed, content and source of seed are supplied for various species of *Trifolium*, *Medicago*, *Lotus*, *Arrhenatherum*, *Lolium*, *Dactylis*, *Festuca* and *Poa*.

RESEARCH: **22.** (a) Manuring of meadow soils with phosphates.

(b) Effect of applying artificial fertilizers, especially phosphorus, in improving alpine swards.

(c) Testing agricultural value of various grasses and legumes.

(d) Sowing of seeds mixtures with reference to suitable cover crop, first-year cultivation, rate of seeding, etc.

(e) Breeding of maize.

INVESTIGATOR: Dr. F. T. Wahlen and associates.

RESULTS: See Gisiger, *Herb. Abstr.* 4. 33-4. 1934.

RESEARCH: **23.** Recording of diseases, weeds and pests on herbage and forage plants.

INVESTIGATOR: Dr. E. Neuweiler.

INDIA. **(54)**

Publication: Annual Report of the Department of Agriculture, Bengal, for the year 1932-33. Parts 1 and 2.

RESEARCH: **24.** (a) Selection of types of juar (*Andropogon sorghum*) and maize.
(b) Tests of American versus local silage maize.
(c) Distribution of cuttings of Napier grass (*Pennisetum purpureum*).
(d) Trial of *Andropogon* spp., *Panicum* spp., and African Veldt grass.
(e) Grass seeds mixtures.
(f) Manuring of local permanent pasture.
(g) Testing of cowpeas and other legumes.

INVESTIGATOR: D. Dutta, Second Economic Botanist, Bengal.

LOCATION: Central Research Station, Dacca, Bengal.

RESULTS: (a) The following types of juar have been found and are being multiplied (1) early saccharine, (2) early non-saccharine, (3) medium-late.
(b) 80,000 cuttings were distributed.
(c) Varieties Groit, Whip-poor-will, Brabham, Victor and New Era are promising. Seeds of the first two are being multiplied for distribution.

Publication: Report of the Agricultural Department, Bihar and Orissa for the period from 1st April, 1932, to 31st March, 1933. Patna, 1933.

RESEARCH: **25.** (a) Trials with *Trifolium alexandrinum*.
(b) Trials with *Pennisetum purpureum*.
(c) Ensilage from dry maize stalks.

INVESTIGATOR: Director of Agriculture and Assistant Economic Botanist; and Deputy Director of Agriculture, Chota, Nagpur.

RESULTS: (a) This is a most valuable fodder, especially for milch cattle; it is very important in the successful cultivation of cheap fodder.
(b) Napier fodder was also in fair demand.
(c) Excellent fodder has been prepared, but details of the method are not yet complete.

RESEARCH: **26.** (a) Observations on merits of berseem (*Trifolium alexandrinum*).
(b) Trials with lucerne and shaftal (*Trifolium resupinatum*).

INVESTIGATOR: Deputy Director of Agriculture, Chota Nagpur range.

LOCATION: Kanke Farm, Ranchi.

RESULTS: (a) Thirty acres supplied ample green fodder for about 4½ months of the year. Yield of seed was satisfactory. Seed production of berseem exhausts the crop considerably.

(b) Lucerne plots receiving both lime and inoculant produced good crops. Control plots produced nothing. Lucerne is a much more exacting crop than berseem, and not so adaptable. If its cultivation can be regulated, it will provide welcome fodder in the hot weather when berseem fails.

Preliminary results with shaftal require confirmation. Its growing season is longer than that of berseem.

Publication: Progress Report of the Institute of Plant Industry, Indore, Central India, for the year ending 30th June, 1934.

RESEARCH: **27.** (a) Trials with lucerne alone or in mixture with *Andropogon sorghum* var. *Sudanensis*.

(b) Tests with soybeans.

(c) Comparison of feeding values and yield as well as the proportion of edible and non-edible varieties in rich and poor natural pastures.

(d) Special method of making silage.

RESULTS: (a) Further agronomic adjustments are necessary. Growing on low ridges with indirect watering along furrows appears to give better results.

(b) All the American varieties imported grew satisfactory at Indore. The value of the crop as fodder is little known locally.

(c) Rich grass areas give three times as much bulk fodder as poor grassland and contain fewer non-edible weeds. Applications of ammonium sulphate raises poor to the level of good grassland. Superphosphate had little or no effect.

CYPRUS. (584.8)

Publication: Annual Report of the Department of Agriculture for the year 1933. Nicosia.

RESEARCH: **28.** (a) Fungous diseases of legumes.

(b) Fungous diseases of lucerne.

INVESTIGATOR: Mycologist (R. M. Nattrass).

RESEARCH: **29.** (a) Testing of drought resistant grasses and clovers under local conditions.

(b) Observations on the success of a seeds mixture of *Trifolium subterraneum* (3 parts), Wimmera ryegrass (*Lolium* sp.) (1 part), *Phalaris tuberosa* (1 part), and *Chloris gayana* (1 part).

INVESTIGATOR: Government Horticulturist (B. J. Weston).

RESULTS: (b) Good germination was obtained, but certain of the species were later damaged by frost. Wimmera ryegrass is making good progress. (See also *Cyprus Agric. J.* 29. 4-5. 1934.)

STRAITS SETTLEMENTS AND FEDERATED MALAY STATES. (595.2)

Publication: Report of the Research, Economic and Agricultural Education Branches for the year 1933. Kuala Lumpur, 1934.

RESEARCH: **30.** Effect of (i) frequency of cutting, and (ii) different manurial treatments on both yield and composition of grass (*Panicum maximum*) grown on heavy and light soils.

INVESTIGATOR: Division of Chemistry.

COLLABORATION: Officer in charge of Government Experimental Plantation, Serdang.

LOCATION: Serdang.

RESULTS: A preliminary report of results for first six months was published in *Malay. agric. J.* for November, 1933. Weekly system of cutting proved too exhausting and was abandoned. Yields were higher on the heavy soil, and with the three-weekly interval of cutting. Yields increased with all manurial treatments, artificial fertilizers being more effective than cattle manure.

Data are also available regarding effect of cutting and manuring on composition.

RESEARCH: **31.** (a) Trials with *Panicum maximum*.
(b) Trials with fodder grasses for local conditions.
INVESTIGATOR: Officer in Charge, Government Experimental Plantation, Serdang.
COLLABORATION: Division of Chemistry (a).
RESULTS: Progress report of (a) given under item 29. Layout of plots and fertilizer treatment are described.

SUDAN. (624)

Publication: Annual Report of the Gezira Agricultural Research Service for year ended 31st December, 1933.
RESEARCH: **32.** (a) Trials with Sudan grass (*Andropogon sorghum* var. *Sudanensis*), teff. (*Eragrostis abyssinica*) and various Australian species.
(b) Observations on legumes for nodule production and dry-weight of tops.
(c) White flies on *Dolichos lablab*.
(d) Yield tests with legumes (*Dolichos*, "Shambat Indian" bean, *Cyamopsis psolaroides*, and *Melilotus parviflora*).
RESULTS: (a) Sudan grass was fairly successful, but liable to be damaged by *Striga*. *Eragrostis* was only moderately successful and could not resist the hot weather. Only Wimmera ryegrass of the Australian species became established and gave an unsatisfactory growth.

SOUTH AFRICA. (68.01)

Publication: Experiments in progress at the Schools of Agriculture.
SOURCE: Article in *Farming in South Africa*. 9. 297-304. 1934.
RESEARCH: **33.** Experiments (24) with maize, with special reference to breeding, rotation, soil preparation, green manuring, fertilizers, silage, transpiration, irrigation and variety tests.
LOCATION: Potchefstroom, Cedara and Grootfontein Schools of Agriculture.
RESULTS: Brief notes as to the progress of all experiments are given in the Journal.

RESEARCH: **34.** (a) Lucerne irrigation experiment: To determine the duty of water for lucerne under karroo conditions and the effect of different irrigations on soil properties.
(b) Lucerne—best stage of cutting for hay; to determine effect on yield and quality.
(c) Lucerne seed production; to determine best cutting for seed, and stages at which to irrigate.
(d) Lucerne grazing experiment; to ascertain carrying capacity and effect on stand and yield of grazing at different times.
(e) Lucerne variety trial; to compare varieties under Karroo conditions.
(f) Lucerne international experiment to compare eight foreign varieties with S.A. Provence.
(g) Lucerne fertilizer experiment; to compare effect of fertilizers on lucerne growing on alluvial soil.
(h) Lucerne irrigation experiment; to determine duty of water for lucerne on the Fish River.
(i) Lucerne fertilizer experiment; to determine effect of fertilizers on lucerne on the Fish River.
(j) Lucerne transpiration experiment; to determine consumption rate of water.
LOCATION: Grootfontein School of Agriculture and Mortimer.
RESULTS: Progress reports and references to articles are given. Item 34 (f) is the International Lucerne Test organized in different parts of the world by the Herbage Bureau.

RESEARCH: **35.** Trials with winter cereals, including comparison of effects of one, two or three grazings on yield, composition and carrying capacity, and the effect of size of paddock.
LOCATION: Grootfontein School of Agriculture.

RESEARCH: **36.** Trials with sorghum, with reference to breeding of witchweed-resistant types, variety trials and agronomical methods.
LOCATION: Potchefstroom, Glen and Grootfontein Schools of Agriculture.

RESEARCH: **37.** Experiments with cowpeas (*Vigna sinensis*), including breeding of upright types resistant to *Phyllosticta* leaf spot and eelworm, and variety trials for hay.
LOCATION: Potchefstroom and Glen Schools of Agriculture and elsewhere.

RESEARCH: **38.** Trials with soybeans for seed and for hay.
LOCATION: Potchefstroom and elsewhere.

RESEARCH: **39.** (a) The most suitable dryland fodder crops for local conditions.
(b) Water requirements of saltbush (*Atriplex*); to ascertain to what extent saltbush can economically be irrigated.
(c) Some experiments with spineless cactus (*Opuntia*).
LOCATION: (a) Glen School of Agriculture.
(b) and (c) Grootfontein School of Agriculture.
RESULTS: (a) Nyati and amber cane gave highest yields, but teff (*Eragrostis*) gave finer hay.
(b) Saltbush yielded nearly 2.7 times as much edible dry matter per unit of water as lucerne, and 2.92 times more digestible protein.
(c) Spineless cactus yielded 8.2 times more edible material than lucerne and 3.15 times more than saltbush. It yielded approximately the same amount of digestible protein as saltbush.

RESEARCH: **40.** (a) The effects of different systems of grazing and of burning on typical veld.
(b) The reaction of veld to different treatments found in farming practice.
(c) Effect of fertilizers on hay yields.
(d) Test of a definite system of veld-grazing, to ascertain the effect on carrying capacity, plant population and plant succession, in comparison with continuous grazing.
(e) Effects of fertilizer on veld.
(f) Collection of information regarding feeding value of various native fodder plants.
LOCATION: Potchefstroom, Cedara, Glen and Grootfontein Schools of Agriculture.
RESULTS: Certain results have been, or are about to be published.

RESEARCH: **41.** (a) Seasonal composition of pastures.
(b) Trial plots of pasture species.
(c) Conservation of surplus summer grass as silage.
LOCATION: Cedara School of Agriculture.
RESULTS: (a) Results published in Division of Chemistry Bulletins Nos. 104 and 120.

RESEARCH: **42.** (a) Trial of grasses for grazing.
(b) Comparison of strains of *Digitaria* (woolly finger grass) and *Chloris gayana* as regards carrying capacity and longevity of the pasture.
(c) Seeding habits of indigenous grass species.
(d) Effect of fertilizers on their composition and palatability.
(e) The degree of susceptibility to witchweed attack of grasses most suitable for propagation in the summer rainfall area.
(f) Breeding of *Chloris gayana* for hay and grazing.
(g) Breeding of a perennial and non-poisonous sorghum for hay.
(h) Inclusion of indigenous and other clovers in grass mixtures.
(i) Variety test of grasses for coast.
LOCATION: Glen School of Agriculture (a).
Potchefstroom School of Agriculture (b)—(f).
Bathurst.

RESEARCH: **43.** Variety trials and other experiments with field beans and peas.
LOCATION: Grootfontein School of Agriculture.

RESEARCH: **44.** (a) Trials with the grazing of sheep and cattle on cactus, saltbush and lucerne.
(b) Feeding cattle with lucerne hay and spineless cactus, and with lucerne-molasses silage.
LOCATION: Grootfontein School of Agriculture.

NORTHERN RHODESIA. (689.4)

Publication: Annual Report of the Department of Agriculture for the year 1933. Livingstone, 1934.
RESEARCH: **45.** (a) Establishment of pastures.
(b) Improvement of ruined pastures.
(c) Colonization of natural veld.
(d) Study of species for pasture purposes.
(e) Seasonal changes in pasture composition.
LOCATION: Mazabuka Experimental Station.
RESULTS: Observations are dealt with elsewhere in these *Reviews*. Owing to severe retrenchment, the experiments at Mazabuka have had to be discontinued. The results of the pasture programme given on pp. 8-10 of the Report are of a preliminary nature.

TANGANYIKA TERRITORY. (689.63)

Publication: Annual Report of the Department of Veterinary Science and Animal Husbandry, 1933. Dar es Salaam, 1934.
RESEARCH: **46.** (a) Value of *Panicum maximum* as silage.
(b) Digestibility and composition of young leaves of the shrub, *Disperma trachyphyllum*.
(c) Composition of star grass (*Cynodon plectostachyum*) under different systems of cutting.
INVESTIGATOR: Biochemist (M. H. French).
LOCATION: Mpwapwa Laboratory..
RESULTS: See separate review in this issue.

RESEARCH: **47.** (a) Review of pastoral conditions in various districts of the Territory.

(b) Pasture improvement (trials of suitable species, methods of testing, browse plants).

(c) Grazing tests (method of estimating carrying capacity, palatability of weeds, and shrubs, carrying capacity of thicket plot, carrying capacity of cultivated pastures).

(d) Ecology of pastures.

(e) Range management (seasonal use of pastures).

(f) Effects of fire on mountain grassland.

(g) Run-off and soil erosion.

(h) Erosion control.

(i) Water conservation in sub-arid districts.

INVESTIGATOR: Pasture Research Officer (R. R. Staples).

COLLABORATION: Director of Veterinary Services, Biochemist and others.

RESULTS: See separate review in this issue.

CANADA. (71)

Publication: Fifty-ninth Annual Report of the Ontario Agricultural College and Experimental Farm, 1933. Toronto, 1934.

RESEARCH: **48.** (a) Breeding of improved, leafy, winterhardy strains of grasses and clovers adapted to local conditions.

(b) Building up of a local seed production industry.

(c) Improved strains of *Dactylis glomerata* for hay and pasture.

(d) Improved strain of *Phleum pratense* for hay.

(e) Breeding of lucerne for winter resistance.

(f) Breeding of soybeans for greater yields of hay and regular seed production.

INVESTIGATORS: Department of Field Husbandry.

RESULTS: The general aim is to combine the good qualities of Russian and other North European and Ontario strains by selection and cross-hybridization, thus breeding strains adapted to Ontario conditions.

RESEARCH: **49.** Improvement of pastures, by topdressing, cutting of pastures and influencing quality of pasture by a combination of different pasture mixtures and pure species of grasses. (Grass species include *Agrostis*, *Poa pratensis*, *Dactylis glomerata*, etc.)

INVESTIGATORS: Department of Field Husbandry.

UNITED STATES OF AMERICA. (73)

Publication: Annual Report of the Massachusetts Agricultural Experiment Station for the fiscal year ending November 30th, 1933. Amherst, Massachusetts, March, 1934.

RESEARCH: **50.** (a) Topdressing of upland permanent pastures.

(b) Comparison of longevity of alfalfa stands, with particular reference to influence of fertilizer and lime applications.

(c) Varietal tests with alfalfa, *Trifolium pratense*, *Vicia*, soybeans, *Melilotus*, *Trifolium incarnatum* and *Lespedeza*.

(d) Effect of variations in fertilizer ratios and forms of nitrogen on yields of hay.

INVESTIGATORS: Department of Agronomy.

RESULTS: (a) Marked response to applied nitrogen, medium response to potash and lime, slight increase due to superphosphate.

(b) Marked differences were found between varieties, but no differences could be assigned to fertilizer or lime treatments.

(c) Details are given.

(d) The forms of nitrogen used were ammonium sulphate, urea, nitrate of soda and cyanamid. The last named came from last place in previous year to first place in the current year.

RESEARCH: **51.** Studies in the chemical composition of pasture grasses.

INVESTIGATORS: Department of Plant and Animal Chemistry.

RESULTS: Some results have already appeared in Bulletin No. 300 of the Station. The plots are to be used to study the effect of fertilizers on the chemical composition of individual species.

Publication: Forty-fourth Annual Report of the Storrs Agricultural Experiment Station, Storrs, Connecticut, for the year ending June 30th, 1932.

RESEARCH: **52.** Alfalfa experiments; response to soil treatments.

INVESTIGATORS: Department of Agronomy (1932-33).

RESEARCH: **53.** (a) Effect of fertilizer treatments on the soil, flora and production as measured by grazing.

(b) Effect of time of cutting on bushes and weeds.

(c) Response of pasture species to plant nutrients.

(d) Adaptability of varieties and species of grasses and clovers for pastures.

(e) Relation between chemical reactions of the soil and the response to fertilization of vegetation on permanent pastures.

INVESTIGATORS: Department of Agronomy (1932-33) (B. A. Brown).

RESULTS: The above items (52 and 53) and the following (54) are projects for the year following the report. A brief summary of the pasture work as reported by B. A. Brown will be found elsewhere in these *Reviews*.

RESEARCH: **54.** Biennial sweet clover (*Melilotus*) for local pastures.

INVESTIGATOR: Department of Agronomy (1932-33).

Publication: Forty-sixth Annual Report of the Cornell University Agricultural Experiment Station, 1933.

RESEARCH: **55.** (a) Cross-inoculation of legumes.

(b) Attempts to increase Rhizobium in soils by fertilization.

(c) Frequency of leguminous plants on the soil in relation to the presence of the legume bacteria.

(d) Adsorption of bacteria by soils.

(e) Adaptability of wild white clover (*Trifolium repens*) to certain types of soil.

(f) Preliminary study of conditions favouring growth of Rhode Island bent (*Agrostis* sp.) and *Poa pratensis*.

(g) Protein and calcium content of plants of *Phleum pratense* when grown on soils of varying acidity.

(h) Pasture survey (phosphorus, deficiency, botanical composition and carrying capacity).

(i) Mineral composition of pasture herbage.

(j) Response of soils to fertilizer treatment, measured by means of pot trials of herbage species.

(k) Tests of pasture plants in mixtures, alone and with wild white clover to determine productivity at various stages during the season.

(l) Effect of wild white clover on the growth of grasses.

(m) Mixtures for use both as hay and pasture.

(n) Grazing experiment to determine relative merits of various methods of pasture improvement.

INVESTIGATORS: Department of Agronomy.

COLLABORATION: Certain items with the Department of Animal Husbandry, and the Office of Forage Crops of the United States Department of Agriculture.

RESULTS: Some data are available on certain of the projects.

RESEARCH: **56.** (a) Value for dairy cows of early-cut timothy hay fertilized with a nitrogenous fertilizer.

(b) Nutritive value of proteins of alfalfa hay and of clover hay.

(c) Pasture improvement studies.

INVESTIGATORS: Department of Animal Husbandry.

COLLABORATION: Department of Agronomy (D. B. Johnstone-Wallace) and others.

RESEARCH: **57.** Breeding of a variety of soybean suitable as a high-protein concentrate for use with oats, barley and corn as a dairy-cattle feed.

INVESTIGATORS: Department of Plant Breeding.

RESULTS: One of the most promising strains is being tested and introduced to local farmers.

Publication: Forty-sixth Annual Report of the Georgia Experiment Station for the year 1933-34. Experiment, Georgia.

RESEARCH: **58.** (a) Small grains and winter legumes for hay (oats, wheat, vetch and Austrian peas).

(b) Soybean breeding.

(c) Forage crop following small grains (sorghum, *Vigna sinensis* and soybeans).

(d) Sweet potato (*Ipomoea batata*) as a feed for swine.

(e) Study of methods of pasture management.

INVESTIGATORS: Department of Agronomy (a-c) and Department of Animal Industry (d and e).

Publication: Fifty-second Annual Report of the Ohio Agricultural Experiment Station, 1932-33. Wooster, Ohio, 1934.

RESEARCH: **59.** (a) Effects of fertilizers in changing the flora of permanent pastures.

(b) Dry method of inoculating legume seed.

(c) Rate of seeding alfalfa.

(d) Scioto soybeans (a new local selection from Manchu) for seed and hay under local conditions.

(e) Calcium-phosphorus ratio in hay crops.

(f) Establishment and maintenance of turf.

INVESTIGATORS: Department of Agronomy.

RESEARCH: **60.** (a) Silage without hay for dairy cows.
(b) Feeding wheat to dairy cows.
(c) Sudan grass (*Andropogon sorghum* var. *Sudanensis*) as pasture.
INVESTIGATORS: Department of Dairy Industry.

RESEARCH: **61.** (a) Quality of hays.
(b) Forage crops for pigs.
(c) Pasturing sheep on wheat.
(d) Sudan grass or soybeans and Sudan grass (for sheep pasture).
INVESTIGATORS: Department of Animal Industry.

Publication: Report on Agricultural Research of the Iowa Agricultural Experiment Station for the year ending June 30th, 1933. Ames, Iowa.

RESEARCH: **62.** (a) Relation of fungi to respiration and fermentation occurring in stored hay.
(b) Control of noxious weeds.
INVESTIGATORS: Section of Botany and Plant Pathology.

RESEARCH: **63.** (a) Value of various legumes as green manure.
(b) Legume and grass species.
(c) Legume and grass species in pure and mixed seedings for hay and pasture.
(d) Factors influencing success of plantings of small-seeded legumes.
(e) Comparisons of sweet clover species, varieties and strains.
(f) Effect of time and number of cuttings on alfalfa.
(g) Factors involved in curing and storage of hay.
(h) Isolation and increase of superior strains of reed canary grass (*Phalaris arundinacea*).
(i) Value of Iowa Phalaris grass on different soils in the State.
(j) Hard seed in legumes and their value when sown.
(k) Breeding and selection in soybeans.
(l) Comparison of foreign, imported and American red clovers.
(m) Alfalfa variety and strain studies.
(n) Cultural studies in alfalfa production on bacterial wilt-infested soil.
(o) Adaptation of soybeans to local soil and climatic conditions.
(p) Comparison of rates, methods and times of seeding alfalfa.
(q) Cultural and adaptation studies with *Phalaris arundinacea*.
(r) Effect of cutting red and alsike clovers at different times.
(s) Technique for determining water content of green forage.
(t) Comparison of American strains of medium red clover.
(u) Effect on alfalfa of spring-burning natural mulch material.
(v) Effect of different cultural treatments on the eradication of biennial sweet clovers.
(w) Permanent pasture improvement.
INVESTIGATORS: Farm Crops Subsection of the Farm Crops and Soils Section.
RESULTS: Results are available on most of the projects. See Report.

RESEARCH: **64.** (a) Effects of fertilizers on crops and soil conditions.
(b) Effects of fertilizers and methods of grazing on soil conditions and plant growth on permanent (*Poa pratensis*) pasture.
(c) Legumes as green manure.
(d) Commercial cultures for inoculation of legumes and non-legumes.
(e) Effects of lime and legume inoculation on crops.
(f) Soil studies (soil erosion, alkaline soils, etc.).
INVESTIGATORS: Soils subsection of Farm Crops and Soils Section.

BRITISH GUIANA. (881)

Publication: Administration Report of the Director of Agriculture, British Guiana, for the year 1933. Georgetown, Demerara, 1934.
RESEARCH: **65.** (a) Trials with forage crops (species of *Tripsacum*, *Pennisetum*, *Melinis* and *Panicum*).
(b) Observations on *Spartina*.
(c) Chemical analyses of fodder crops and grasses, with particular reference to seasonal composition.
RESULTS: (a) *Tripsacum laxum* is most promising:
(b) *Spartina Townsendii* cannot compete with *S. brasiliensis*.

NEW ZEALAND. (931)

Publication: Annual Report of the Department of Agriculture for 1933-34. Wellington, 1934.
RESEARCH: [Only those items not listed on pp. 52-4 of *Herb. Rev.* for March-June, 1934 are included].
66. (a) Breeding of rape.
(b) Dual seed-crop production
(c) Feeding value and chemical composition of rape.
(d) Control of grass-grub (*Odontria zealandica*) on lawns.
(e) Differentiation between seedlings of early- and late-flowering strains of red clover.
INVESTIGATORS: Agronomy Section (a), Agrostology Section (b), Field Experiment Section and Chemical Section (c), Entomology Section (d), and Seed Testing Section (e).
LOCATION: Plant Research Station, Palmerston North.

Publication: Eighth Annual Report of the Department of Scientific and Industrial Research for year 1933-34.
RESEARCH: Little additional to that listed on p. 55 of *Herb. Rev.* for March-June, 1934.

AUSTRALIA. (94)

Publication: Plant Breeding in New South Wales, Seventh Year of Progress, 1932-33. Science Bulletin No. 45 of the New South Wales Department of Agriculture (by H. Wenholz), Sydney, 1934.
RESEARCH: **67.** (a) Breeding of rye for forage.
(b) Breeding of lucerne.
(c) Breeding of sorghum and Sudan grass.
(d) Trials with leguminous fodder crops for summer or winter.
(e) Selection and seed production in pasture grasses and clovers.
INVESTIGATORS: Director of Plant Breeding and Assistants.
LOCATION: Bathurst and Grafton Experiment Farms and elsewhere.
RESULTS: See Bulletin.

Publication: Second Annual Report of the Pasture Improvement Work in the Gippsland and Western District trials.

SOURCE: *J. Dept. Agric. Vict.* 32. 172-202. 1934.

RESEARCH: 68. (a) Manurial trials on pastures; mowing and observation plots.
(b) Rotational grazing plots.
(c) Trials with pasture mixtures and strains.
(d) Weed control on pastures.
(e) Botanical survey.

INVESTIGATORS: Department of Agriculture.

COLLABORATION: Victorian Pasture Improvement League.

RESULTS: Comments on the progress of the various studies are made in the article.

SPECIAL NOTICE

AREA UNDER LUCERNE IN AUSTRALIA.

On page 8 of *Herb. Publ. Ser. Bull.* No. 12 on " Lucerne : its ecological position and distribution in the world," by Dr. M. Klinkowski, certain figures were given as representing the area under this crop in Australia.

The Herbage Bureau has now been favoured with a communication from Mr. R. E. P. Dwyer, formerly of Bathurst Experiment Farm, Bathurst, New South Wales, Australia, giving amended figures for the area and distribution of lucerne in the various States of the Commonwealth of Australia, as supplied to him by E. T. McPhee, Commonwealth Bureau of Census and Statistics, Canberra, F.C.T.

State.	Area Under Lucerne Grown for :			
	Hay.			Green Forage.
	Area (in acres).	Production of hay. (in tons).	Value of hay produced (in £'s).	Area (in acres).
	1921—1922.			
N.S. Wales	77,577	181,714	1,476,430	36,052
Victoria	27,698	47,554	380,000	(b)
Queensland	67,183	100,822	554,521	25,420
S. Australia	4,145	8,638	28,505	23,736
W. Australia	125	125	1,250	3,225
Tasmania	(a)	—	—	(a)
F.C. Territory	50	88	720	—
Total	176,728	338,941	2,441,426	(c) 88,433
	1926-27.			
N.S. Wales	95,003	188,948	1,407,660	90,678
Victoria	20,731	34,588	260,000	117,190
Queensland	33,263	40,601	372,599	40,420
S. Australia	5,613	9,097	31,840	45,551
W. Australia	340	461	3,688	7,763
Tasmania	(a)	—	—	(a)
F.C. Territory	100	122	910	—
Total	155,050	273,817	2,076,697	(d) 301,602

				1931-32.		
N.S. Wales	..	..	..	96,396	154,394	656,170	181,445
Victoria	..	..	..	34,224	51,577	195,000	130,357
Queensland	..	..	..	47,547	79,237	324,542	43,013
S. Australia	..	..	..	5,660	9,233	14,773	7,172
W. Australia	..	..	..	190	265	1,722	5,578
Tasmania	..	..	..	(a)	—	—	(a)
F.C. Territory	..	..	..	174	173	735	542
Total	..	..		184,191	294,879	1,192,942	368,107

(a) Area sown to lucerne in Tasmania is small and therefore unimportant in the aggregate.

(b) Not available.

(c) Exclusive of Tasmania and Victoria.

(d) Exclusive of Tasmania

SOVIET RESEARCH

THE RESULTS OF VARYING THE INTENSITY OF THE FACTORS OF VERNALIZATION.*

V. V. Zerling and A. R. Čepikova.

In 1933, in the agro-chemical laboratory of the All-Union Institute of Fodder, one of the authors (Zerling), working on the basis of Lysenko's theoretical statements, commenced an experiment on the influence on several perennial pasture plants of a complex of factors, wherein the doses of the factors varied for the different plants according to the degree of their perenniality. The following plants were chosen: meadow foxtail (*Alopecurus pratensis*), timothy (*Phleum pratense*) and two varieties of red clover (*Trifolium pratense*): single- and double-cut clovers. The complex of factors included the temperature for the whole period of vernalization, the humidity of the seeds during the period of imbibition (the first 24 hours) and the length of the period of vernalization. Observations and measurements of the yield were made by A. Čepikova.

All the plants studied showed a considerable acceleration of growth, and the more perennial the plant the stronger was the effect of vernalization; therefore, meadow foxtail and single-cut clover in the control plots (unvernalized) did not form buds and did not flower in their first year, whereas the vernalized specimens of these plants not only flowered, but also produced a varying number of panicles and heads in response to modifications of the factors of vernalization. The two other experimental plants, double-cut clover and timothy, not only showed an accelerated growth, but also increased the number of heads and panicles as compared with the control plants, which produced buds and ears, but did not flower.

These results are represented in Table 1 of the article.‡

It must be noted that the influence of the complex of factors causing the processes of vernalization in the plant, produce not only an acceleration of growth and an increase in the number of reproductive organs (heads and panicles), but also in an increase of the growth of the vegetative organs and therefore an increase in the total mass of the yield (see Table 1). This phenomenon once more disproves the statement met in literature that reproductive and vegetative growth are inversely directed processes.

The next point reflected in the experimental data is the different significance of the various factors for plant growth. During the experiment different variants of temperatures, humidity of seeds in the first 24 hours (process of imbibition), and number of days of vernalization were tested. Table 2 shows the changes under the influence of the separate factors of vernalization in the length of the vegetative period from date of sowing until that of flowering.

These data show the significance of the factors of vernalization with respect to different plants. Thus the dominant factor for meadow foxtail is the time duration of the influence, while changes in the other factors have little effect upon the length of the vegetative growth. The length of the period of vernalization has also a strong effect on double-cut clover, but unlike foxtail a higher temperature during the period of vernalization somewhat shortens the length of the vegetative period; a change in the humidity of the seeds had no effect on the rate of growth of the plant. The

*English summary of article in *Doklady Akad. Nauk S.S.S.R.* 3. 472-7. 1934.

‡The tables are available on request.

length of the vegetative period of single-cut clover is affected by all the three factors of vernalization : flowering is retarded 3-4 days by increasing the temperature of the vernalization period from +3 to +8°C., and an increase of humidity of the seeds retards flowering by 7-8 days. A lengthening of the vernalization period shortens the vegetative period by two days.

The above-noted differences in the effects of the factors of vernalization on different plants indicate that the biological properties of the plants are one of the decisive elements in determining the response of the plants to variations in the factors of vernalization and consequently all the further development of the plant. The next point brought out by these expeirmental data is that in most cases the length of the vernalization period is the dominant factor determining the rate of growth and that with the gradual change of this factor the change in the rate of growth of the plant likewise gradually increases. This shows that the process of vernalization occupies a certain duration of time and that all changes in the plant associated with this process effect corresponding changes in the rate of developments.

The study of the influence of these factors on the number of reproductive organs (the heads of clover and the panicles of grasses) is also of interest. In distinction from the effect of the factors of vernalization on the length of the vegetative period, the significance of the separate factors in this case for different plants is almost the same, i.e., the dominant factor is the same for all the plants. In common with the above discussed index of vernalization (length of the vegetative period) the duration of the vernalization period is the dominant factor in most cases : it is so for reproductive organs in the absolute majority of cases and somewhat rarer for the length of the vegetative period. Table 2 shows a greater change in the number of heads (panicles) under the influence of the lengthening of the term of vernalization (vertical direction in the table) than under the influence of the temperature of vernalization or of the initial humidity of the seeds (horizontal rows in the table).

Studies of the physiology of growth are usually based on the rate of growth of the plant. We consider that, besides the rate of growth, it is as important to study the intensity of growth, which we understand as the number of organs produced in each stage. Thus it will consist of the following separate component parts : energy of tillering, leaf formation, earing and so on. A study of intensity of growth is not only of theoretical interest, but also of great practical interest, for the yield is in a greater degree a function of the intensity of growth than of the rate of growth.

These data show first of all that the biological properties of the plants have less effect on the intensity of growth than on the rate of growth. Secondly, the duration of the process of vernalization is one of the primary factors responsible for the formation of one or other member of the reproductive organs, and, consequently, for the yield.

OTHER RECENT ARTICLES ON VERNALIZATION.

Two other articles which have just been received and which deserve mention are the following:

I. M. Vasiljev. [The factors of vernalization of winter varieties.] *Doklady Akad. Nauk. S.S.S.R.* 3. 533-9. (English summary, 537-9.) 1934.

V. V. Zerling and A. R. Čepikova. [On the character of the process of vernalization.] *Doklady Akad. Nauk. S.S.S.R.* 3. 539-43. (English summary, 542-3.) 1934.

Space does not permit the publication of the English summaries in full, as has been done in the case of the first article in this section, by Zerling and Čepikova. They are, however, available on request, together with a table in the second paper by Zerling and Čepikova, presenting results of trials on the phenomenon of reversibility of vernalization as produced in double-cut red clover (*Trifolium pratense*) as a result of prolonging the period of vernalization.

Vasiljev concludes that the conditions created for germinated seeds of winter wheat by vernalization according to Lysenko's method are far from being the only conditions under which the processes necessary for the plants to reach the reproductive stage can proceed. The possibilities for the achievement of these processes are much more varied. These conditions are not those which ensure the most rapid completion of the processes leading to reproduction.

Working on *Trifolium pratense*, Zerling and Čepikova now find that, by using increases in the period of vernalization beyond a certain number of days, a negative reaction was produced, i.e., the plants either did not flower or flowered after a delay of almost 18 days, forming considerably fewer heads than plants of the preceding variants in the same experiment. The authors conclude that these results lead to the assumption that the stage of vernalization is a gradual process of the formation of new qualities with the accumulation of qaantitative changes, and not an instantaneous acquisition of new properties.

A complete review of these and other papers will be found in Bulletin No. 16 of the Herbage Publication Series issued by this Bureau, entitled "The theoretical significance of vernalization," by Professor N. A. Maximov (December, 1934), price 2s. 6d.

[See also *Herbage Abstracts* 4. 224-6. 1934.]

THE ADJUSTMENT OF SOWING MACHINES FOR SIMULTANEOUS SOWING OF FORAGE AND NURSE CROPS.

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For economy of time and work, when forage plants are to be sown with a nurse crop, sowing machines with boxes specially designed for the sowing of forage crops are being widely used. The use of these boxes makes it possible to sow seeds of forage plants and those of the nurse crop at the same time ; otherwise such a sowing must be made in two processes.

This method has received the widest use in North America, where a considerable number of firms have been engaged in the construction of such sowing machines. The use of these outfits is now spreading to countries in which the cultivation of forage plants is of more recent origin.

If the so-called narrow drill sowing of forage plants is desired, i.e. sowing through all the coulters of the machine, there is no reason for disagreeing with the suitability of this method. No matter whether such sowings are to be used for forage or seed purposes, in either case, modern agricultural engineering is not in a position to suggest any other device. The matter is, however, quite different, when fodder and particularly meadow plants are grown for seed only and sown in wide drills spaced 20 — 40 or 60 cm. apart. It should be added that in some places the area under such sowing covers thousands of ha. or more. It is natural that under these conditions, serious attention should be paid to such adjustments of sowing machines which, without decreasing the quality of work, will enable agriculturists to dispense with additional boxes or seed conductors, not to mention special additional forage plant coulters. Such is, at the present time, at least in the Soviet Union, the state of the matter with sowing machines for meadow and other plants, when intended to be sown for seed in wide drills.

Large scale cultivation of seed crops in wide drills may be possible in U.S.S.R. only with complete mechanization of the whole procedure of the industry and with the greatest possible reduction in the cost of the machines used.

For simultaneous combined sowings of forage plants and nurse crops in U.S.S.R., M. M. Rožkov, research worker at the Institute of Mechanization of Agriculture, has suggested a very simple and inexpensive device which consists of stopper rings attached to the sowing roller, and in transverse partitions constructed inside the seed box. The partitions which should preferably be removable divide the seed box into a number of compartments or bins according to the number of coulters. In some of these bins seeds of forage plants are loaded, whereas in the others are placed those of nurse crops (wheat, oats, etc.) or, sometimes, seed of annual plants (*Lolium westerwoldicum*) used as the nurse crop. Such a sowing of forage crops is said to be " semi-covered, lightened," for the nurse crops are sown not by all the coulters but only by those which coincide with the interspaces between the forage seed coulters.

We shall describe below an adjustment of sowing machines with Huzier's reel ; the idea of the device is, however, so simple that sowing machines with another type of sowing apparatus may be similarly adapted. If the size, shape and running ability of seed of the forage and the nurse crops were the same, a combined simultaneous sowing would present no difficulty whatever, and the adjustment of the sowing machine for a required sowing would differ in no respect from the ordinary. Usually, however, with simultaneous sowing of forage and nurse crops, the adaptation of sowing machines for sowing of seed of one plant does not give the rate required for sowing of seed of the other. Hence, it is necessary to adjust the sowing aperture, i.e., the length of the working part of the reel for other seed, for which purpose an

additional re-adjustment of the reels is needed. The re-adjustment should be made in the vicinity of the reels of the sowing apparatus intended for sowing the forage crop, for, with wide-drill sowing of the latter, the number of the apparata will be smaller than that of apparata sowing cover crop.

To regulate the position of the reels on the sowing roller, the "splints," which hold these reels, should be removed from either side of the apparatus and replaced with stopper rings fixed by screws (Figs. 1 and 2). The projections (a) of the stopper

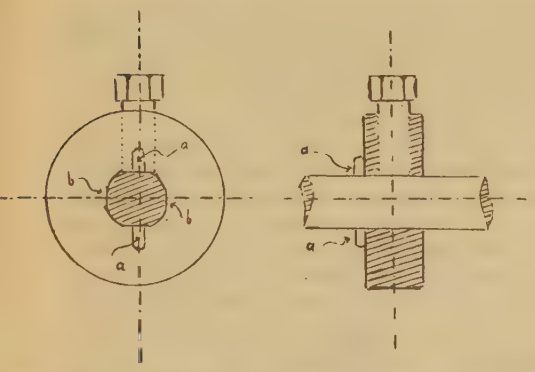

FIG. 1.—Stopper rings attached to the cylindrical roller. (a=projections of the rings; b=flattened surfaces on the cylindrical roller.)

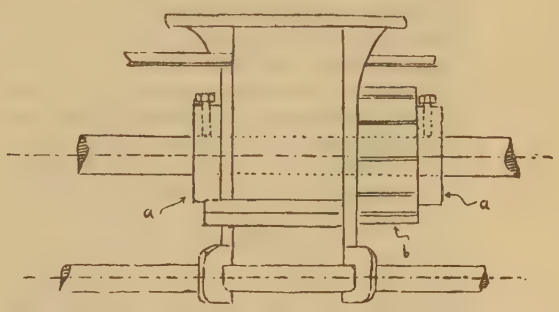

FIG. 2.—Huzier sowing apparatus with the stopper rings. (a=rings; b=reel.)

rings should be adjusted so carefully that they would be kept firmly in the corresponding notches of the reels and prevent any rotation (vibration) of the latter on the roller after the screws have been fixed. Otherwise, these vibrations will cause an uneven rate of sowing in the row. In addition, if the sowing roller is cylindrical, it should, within the limits of the transmission of the rings, be slightly flattened and screws should be fastened on the cut surface (b); otherwise slipping and misplacing of the ring might easily occur.

When the stopper rings are used, in the first place, the adjustment of the sowing machine is usually made for seed of the nurse crop in accordance with the number of coulters intended for this purpose. Thus, if in the 24 row sowing machine of MacCormick Deering model for broad drill sowing, 8 coulters be selected for the forage crop, the remaining 16 coulters will sow the nurse crop (one herbage plant coulter will alternate with two coulters of the nurse crop.) If the rate adopted for close drill sowing of the nurse crop (by all the coulters of the sowing machine) is 150 kg. per ha., then, accordingly for 16 coulters, 100 kg. should be sown per ha., i.e. 50 kg. per ha. for each half of this sowing machine, and 2 kg. of seed for each half to check the adjustment by the rotation of wheels (if calculated, for instance, per 0.04 ha.)*

When the regulating index of sowing has been fixed, the reels intended for broad-drill sowings of forage plants are to be adjusted by means of the stopper rings. The length of the working part of one of these reels is provisionally given at 2 — 8 mm., according to the sowing rate and size of seed. Further, a preliminary test is made by rotation of wheels, corresponding to say 0.04 ha. On weighing sown seed and finding the rate to be either too large or too small, the size of the sowing apertures is accordingly decreased or increased until the size is fairly near to that required. Thus, if for a wide-drill sowing, 6 kg. of forage plant seed are required per ha. and if with the

*In U.S.S.R. for the sake of accuracy, it is usual to check the adjustment of sowing machines by means of a preliminary rotation of wheels corresponding to 0.01-0.04 ha.; the seed thus "sown" are weighed and an appropriate calculation is made of the rate per ha. The index of the rate is used only for a preliminary testing arrangement.

forage plant apparatus alone (when the length of the working part is 4 mm., and the area 0.04 ha.) 40 gr. were sown, then such an arrangement will sow 40 gr. × 25 × 8= 8 kg. per ha. Decreasing the size of the apertures to 3 mm. and obtaining about 30 gr. of seed sown through one aperture by rotating the wheel corresponding to 0. 04 ha. we can assume that such an arrangement of the reel will sow 30 gr. × 25 × 8=6 gr. per ha. Therefore sowings can be made after fixing all the reels of forage plant apparatus by means of the stopper rings to ensure that the length of the working part is 3 mm.

Forage plant coulters, for such a combined sowing may be raised as high as required for the depth of covering forage plant seeds. It is obvious that in thick drill sowings of nurse crops, when the seed conductors of forage boxes are let into the seed coulters of a large grain box, the depth of covering of forage plant and nurse crop seeds will be the same, and therefore unfavourable for either.

The stopper rings make it possible not only to employ a combined sowing, dispensing with additional forage seed boxes, but also to check incorrect spacing of reels on the sowing roller at which the difference in the length of working parts of some reels of certain machines approaches 2 —3 mm. With small rates of sowing and short drawing of reels of the apparatus (short working part), this rough spacing causes such uneven sowing by the apparatus that some coulters sow two or three times as much as the others. Spacing of reels and sowing apparata in such sowing machines must, therefore, be corrected by means of the above described stopper rings. It is also useful to provide the cereal apparatus with the stopper rings.

With sowing machines of other types, the combined sowing of forage and nurse crops may be made by means of the same stopper rings ; thus, reels with inner ribs, if they are regulated by transferring of the sowing roller. With the apparatus of another type, the alteration of the size of the sowing apertures, for instance, is made by means of an additional cover at the exit aperture of the apparatus. At the present time a number of experimental combined sowings of different plants is being made at the experiment stations of U.S.S.R. with the use of the stopper rings. In agricultural practice this method, being considerably cheaper, will certainly replace the use of the forage seed boxes.

INVESTIGATION OF HYBRIDS OF SORGHUM AND SUDAN GRASS.*

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Introduction.

Although sorghum and Sudan grass belong to the same species (*Andropogon sorghum*), they differ markedly in a number of morphological and other characters, in variability and agricultural use. Sudan grass is an important drought resistant annual forage plant, capable of producing green forage, hay and pasturage, and under appropriate agronomical treatment is superior in yield to other annual plants. Of particular value is its capability to grow after cutting, even under extremely unfavourable conditions of summer drought when all other plants would wither. Sorghum, on the other hand, falls into three very distinct agricultural groups and thus has a wider range of agricultural value, both as a fodder and an industrial crop. Apart from their practical value in the steppes, the profound difference of these plants in respect of many characters and their suitability for the study of so-called " quantitative " characters render them worthy of study.

Cytological investigations made by the authors in 1923-29 and later confirmed by other investigators show that sorghum and Sudan grass are similar in chromosome number (n = 10), while Johnson grass has n = 20 ; the size of the chromosomes is, however, different.

Material and Technique.

Sorghum and sudan grass are characterized by open flowering ; the anthers ripen after emergence from the glumes and somewhat before the stigmas. Methods adopted for some self-pollinating grasses cannot, therefore, be employed. As transference of pollen with a brush does not guarantee purity in the vicinity of Odessa, owing to frequent windy weather, a "rationalized' method of crossing sorghum has been evolved which under proper conditions ensures a high percentage of setting of hybrid seed.

The maternal raceme is taken at a time when its upper portion begins to flower. The upper and lower spikes are removed, while in the central portion about 100—200 hermaphrodite florets are emasculated, the anthers being removed by forceps. The remaining hermaphrodite and all the male florets are carefully removed. The retained florets must occupy the largest possible area and be situated approximately in the same plane. After emasculation the racemes are lightly sprinkled with water and covered with a parchment isolator until the stigmas ripen. After the emergence of the stigmas one or two days later a test tube with water is attached to the raceme ; into this test tube are placed one or several racemes from Sudan grass so that they will be somewhat above the emasculated sorghum raceme, and both are then covered by the isolator. This must be done in the evening when the air is damp. In the morning the racemes must be shaken to ensure shedding of pollen on the sorghum stigmas. Fresh racemes of Sudan grass are supplied several times until the stigmas wither. Only lateral racemes are isolated, the main ones being used for measuring and description. Since the F_1 generations of the reciprocal crosses between sorghum and Sudan grass do not differ in any respect, for the sake of convenience in the method described, sorghum is always taken as the seed parent.

*This article is to be regarded as a detailed authors' abstract of various articles, published and in the press, in Soviet Journals. It is the third of the series intended to give an idea of some of the work in progress at the Odessa Institute, the centre of the vernalization research. The English translation has been checked by the authors and the Editor can take no responsibility for the presentation of the results or their interpretation.

The hybrid seeds are sown in paper boxes in nurseries, as this ensures optimum conditions for seed development and is convenient for observation. At the stage of emergence of the second or third sheath the seedlings are planted out in the open at a spacing of 50 × 50 cm.

During the vegetative season records were kept as follows :—

(a) the character of germination in the nurseries, (b) character of plants in the open before tillering, (c) marking and measuring of plants at emergence of axis, (d) the same after complete emergence of raceme, (e) detailed description of hybrids in comparison with parental forms at complete maturity of the main raceme.

Measurements were made of the height of plants (cm. rule), tillering (by counts), number of leaves (by counts), and cross sections of stems (measuring fork). The remaining characters, such as presence or absence of glumes and awns, colour of glume, gloss and colour of sheath, etc., were estimated by eye, chief attention being given to characters of forage value. Hybrids were measured twice, namely, at the time of emergence of axis (1st measuring) and at the end of the vegetative season (2nd measuring).

Isolated racemes were threshed by hand and their seeds were mixed only after careful scrutiny and comparison. If the number of seeds was too large for counting, it was calculated from the absolute weight.

Sowing of F_2—F_5 and their parents was done by hand planter with markers, in rows 50 metres long, with a spacing of 25 cm. between the plants and 50 cm. between the rows, for owing to somewhat incomplete germination (65—70 per cent) the hybrid sowings became thinner.

F_1 Generation Hybrids.

The following sorghum varieties were involved :

Red Caoling No. 182 (grain), Minnesota Amber No. 25 (sugar), both bred at Odessa, Broomcorn No. 17 (Kherson Station), Feterita, white Caoling, Sumak, Tall Eritrea, a natural hybrid of broomcorn with Sudan grass (called "Giant"), Red Caoling No. 92, etc. Typical forms of Sudan grass were used, such as Dwarf (ordinary and violet-striped), Arrow, Tall and others.

The combinations under investigation may be divided into three categories, namely, grain sorghum × Sudan grass, saccharine sorghum × Sudan grass and broom sorghum × Sudan grass. The general character of racemes in all three groups is like that of Sudan grass (even in hybrids of broom sorghum). In all cases complete fertility, even higher than in the parental forms, was observed, and the reduction division was apparently normal.

The F_1 hybrids were intermediate as regards characters most typical of either parental forms (such as shape and weight of grains, tillering, height of plants, etc.). In some other characters, such as glumeness, colour of grains, etc., a complete dominance of Sudan grass was found, whereas in the colour of coleoptile and sheath both Sudan grass and sorghum can predominate.

Back-crossing of F_1 hybrids with Sudan grass produces a type different from parents and resembling Sudan grass. The whole constitution of the F_1 generation depends, to a certain extent, upon the forms of Sudan grass involved in crossing. This is especially marked in the case of tillering, cross-section of stem and height. On the other hand, different forms of Sudan grass do not always produce different types of F_1.

Analysis of Characters in the F_2—F_5 Generations.

(i) *Colour of glume.* This character is dependent on multiple allelomorphic factors, which in certain combinations are complimentary. The following colour series may be distinguished : red, orange, black, brown, gray, yellowish, yellow. The last, and probably also black colour, give a monohybrid ratio ; the others, however,

segregate in a complicated way and suggest that at least 5 factors are involved and that modifiers are also present ; the red alone can be classified into 4 distinct types.

(ii) *Awn—awnless.* The three distinct classes in F_2 (long-medium-short awn) would indicate that two factors are responsible for this character. The great deviation between the expected and observed number in F_3, however, strongly suggests that either the number of factors is greater, or a more exact discrimination of the classes is necessary.

(iii) *Colour of grains.* The white grain colour of sorghum is recessive to the brown of Sudan grass, and the wide range of segregation in F_2 indicates that this character is polymeric. Owing to the insufficient data, the number of factors is not yet determined. The grain colour is inherited independently of type, and in the F_2 generation Sudan grass forms were found showing white grain colour.

(iv) *Double grain.* This character is very important owing to the causal connection with seed production. It is completely recessive to ordinary grain. In F_2 a dihybrid ratio was obtained, but the variation of this ratio in different crosses suggests that there is some kind of quantitative difference between the factors.

(v) *Glumeness.* In the F_2 several classes were obtained showing different grades. The variation in the sorghum parental type and the wide range of segregated forms in the hybrid generations indicate that this character is polymeric. Its inheritance is very complex and influenced by other characters, such as the type of raceme, the shape of grain.

(vi) *Characters of the vegetative parts.*

(a) Albinism and striping are recessive and give a monohybrid ratio in F_2 generation. Striping is inherited irrespective of colour. The divergence of actual and theoretical figures may be due to a late determination of this character which fades towards the end of vegetative period, and its lower vitality.

(b) Violet colour of shoot is due to the presence of one dominant factor, but its complicated behaviour in F_2 plants suggests that there are different allelomorphic genes showing quantitative gradation.

(c) Dark green is dominant over light green. The intermediate types of F_2 show that this character is polymeric or that modifiers are involved.

(d) The opaque surface of leaves is dominant to glossy in F_1 hybrids. This character behaves similarly to the previous one, indicating that most probably multiple factors are responsible for the various types found in F_2 hybrids.

(vii) *Height and tillering.* Measurements show that, with the exception of two cases of dwarf sorghum, all hybrids are intermediate in respect of height, approaching, however, rather to the tall parent, the difference being directly related to that existing between the parents.

Analysis of segregation in F_2 demonstrates a wide range of variation of hybrids ; forms taller than tall parents and smaller than small parents were found ; the data available are, however, insufficient to detect the exact number of recessive factors, but not less than 4—5 genes must be involved.

In respect of tillering, F_1 hybrids are intermediate, but are nearer to the weakly-tillering parent. It is important from the breeding point of view to note that better results were obtained in F_1 if the parental forms differed but slightly one from another in this respect. The range of variation of F_1 is more narrow than that in the parental forms and heterosis was not observed.

Wide range of variation was found in F_2 ; this indicates that the character is polymeric. There are cases in the F_1 plants of transgression beyond the parental forms. This may be due to the environmental factors, i.e. only modifications, or to gene differences present in parental forms. It is of interest to note that Sudan grass genetic constitution influences the manifestation of this character.

(viii) *Thickness of stems and number of leaves.* These characters are also intermediate. Variation of F_2 in respect of cross-section of stem does not extend beyond the extreme of parental variants, whereas in the number of leaves such transgression was observed.

(ix) *Vegetative period.* In this respect F_1 of all the crosses is intermediate, whereas a segregation occurs in F_2; it was found that the series of early segregates is wider than that of late ones. Transgression beyond the parental forms was never observed. The ratio in F_2 is near the Mendelian monohybrid scheme, but data are too scanty to reveal the real gene constitution. Agricultural maturity does not always show a free combination with other characters, but cases when the same complex is either invariably late or invariably early are relatively rare. In particular, it should be mentioned that the segregates with large forage production are, as a rule, late. The correlation between the length of vegetative period and complexes is still more pronounced in the case of grain maturity: there are segregates which would never ripen under ordinary conditions.

(x) *Sappiness and sugar content.* The Sudan grass type (dry and sugarless) is dominant and depends on several factors. There is a correlation between sappiness and sugar content, but they are inherited as independent complexes.

COMPLEX SEGREGATION.

The detailed analysis of the complicated behaviour of the parental characters in F_2 and subsequent hybrid generations suggests strongly that there are definite complexes showing a definite frequency of occurrence. Thus, when the scale of types was based upon the habits of plants as a whole (A. A. Sapehin's principle, 1928), the following complexes were distinguished: 1=sorghum type, 1a=dwarf sorghum type, 2=intermediate type to F_1, 2a= F_1 type nearer to Sudan grass, 3a, 3b. and 3c=gradations of types of similar to Sudan grass and 0=disfigured, single-stemmed, under-developed segregates.

It was found that the characters involved in these complexes do not show segregation in F_3; this strongly suggests that they are homozygous in F_2. The authors believe that the segregation of the main characters occurs in the hybrids as a "complex" segregation, while on this background free segregation of individual characters proceeds; hence it is very difficult to give a clear-cut analysis.

On the whole, although the chromosome number of the parental forms is the same and the reduction division in hybrids is normal, this segregation resembles closely that found in geographical races. Thus the genotypic differentiation of subspecies and even races may be so great that it results in a mode of segregation which is very similar to that found in interspecific hybridization.

Delaunay (1932) made an interesting attempt to explain this type of segregation by assuming differences either in individual chromosomes—"unipartial" type,—or in the entire set—" omnipartial " type; the latter would show single, and the former complex segregation. The behaviour of characters in F_2 hybrids, however, does not support Delaunay's hypothesis, which cannot explain the constancy of the great majority of segregates in F_2.

The authors suggest that the " complex " segregations can occur not only in interspecific hybrids, but in sub-species and even in geographical races. The process of complex segregation is conditioned by a specific recombination of the chromosome set in gametogenesis, and the " exchange" of chromosomes would occur in groups. Consequently both genetical and cytological analyses are necessary to reveal the mechanism of complex segregation.

This question is of great importance, for curtailing of the formative processes on the one hand, and rapid production of constant forms (even in F_2) on the other require an appropriate revision of the methods of breeding in order that the scale of breeding could be extended only in F_2. In this respect, sorghum—Sudan grass hybrids offer no difficulties whatever, producing a large amount of seeds in F_1.

SIGNIFICANCE OF SORGHUM × SUDAN GRASS HYBRIDS.

The results of segregation of constant hybrids form an excellent basis for building up new varieties of high fodder value, particularly for ensilage. Their value was ascertained in 1933 by varietal tests in which the F_5 hybrids of the Minnesota Amber × Sudan grass took first place. Very late forms which did not even develop racemes are also of value as silage and by methods of pre-sowing treatment (vernalization) it is also possible to obtain seed.

The presence of "complex" segregation makes it impossible to obtain any desired combination by a simple crossing, but it also facilitates the obtaining of a combination, if the given complex meets practical requirements. The data available also indicate the possibility of "breaking" a complex by means of back-crossing to Sudan grass or sorghum according to requirements.

The scale of work required for obtaining valuable forms for practice must in the F_2 consist of 10 —12,000 plants, i.e. relatively few plants in F_1. The best parental pair in respect of silo-forage purposes is the Minnesota Amber 25 and thin-stemmed Sudan grass (Dwarf), for among the segregates there occur especially valuable types possessing thin stem and high content of sugars and sap.

The problem of obtaining hybrids forms of the Sudan grass type suitable for hay purposes, that is, a combination of vigorous growth and tillering with formation of aftermath, succulence of forage and high nutritive value, must be regarded as not yet solved. As has already been said, this should be achieved by back-crossing hybrid forms to Sudan grass.*

Of no less importance is the problem of obtaining perennial forms of sorghum. Work in this direction is in progress; for example in 1933 we obtained an F_1 generation from the cross Minnesota Amber 25 × Johnson grass. After being placed in a greenhouse the three hybrid plants gave normal seed.

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*The authors' attention has been drawn to the possible toxicity of these hybrids at certain stages of development, but no comments have been received.—ED.

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(277) Wt. P.968/167/28241. 50. 8/40. P.L.H. & CO. LTD. G.943.